Master of Software Engineering Portfolio

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0 Abstract

The Goal Model for Dynamic Systems (GMoDS) is a means for specifying system requirements for agent-oriented software at design time and tracking their achievement at run time. The specification goal tree represents the specified requirements at design time. The instance goal tree represents the run time achievement profile of the specified goals.

The GMoDS Visualizer is an optional graphical display of both the specification and instance goal trees and all appropriate relations between the goals. In addition, the visualizer displays goal parameters in both the specification and instance trees and the status and parameter values of instance goals.

The GMoDS Test Driver tests either GMoDS or the GMoDS Visualizer. The Test Driver executes event scripts from a file or by random generation compatible with the GMoDS model being used. The Test Driver operates in automated or manual mode.

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1.1 Introduction

This paper provides the background, motivation, and specific system requirements for a graphical visualization tool employable by software incorporating the Goal Model for Dynamic Systems (GMoDS) [2] component. In addition, the paper specifies requirements for a test driver for GMoDS that can substitute for simulation components as a client of GMoDS. Finally, the paper concludes with assumptions, constraints, and the proposed development environment.

1.1.1 Motivation

Several simulations of agent-oriented systems using the GMoDS system exist but users of these simulations have limited access to the state of GMoDS at run time. Developers of these simulations would find GMoDS run time information invaluable as a debugging tool, but should not be required to use this tool. The GMoDS Visualizer will provide a graphical representation of GMoDS specification goals and run time instance goals with loose coupling to GMoDS allowing for optional use.

Running an agent simulation is more complex and computationally expensive than is necessary to test the Visualizer. The GMoDS Test Driver will test the GMoDS Visualizer by stimulating GMoDS to in turn stimulate the Visualizer, thus allowing an alternative to simulation clients as test mechanisms.

1.1.2 GMoDS

The GMoDS system represents system requirements as goals and their relationships using an *a priori* (i.e., prior to run time) specification tree. See Figure 1 [2] below. Higher level goals can be decomposed into lower level goals using a parent/child relation, forming the tree. Parent goals are related to child goals using either an AND or OR connective. Child goals connected via AND must all be achieved to achieve the parent goal. Child goals connected via OR require only one child to be achieved for the parent goal to be achieved. The specification tree goals can be parameterized and are a template for goals created at run time; such run time goals are called instance goals. Relationships between specification goals represent causal events (“triggers” that create instance goals), negating events (“negative triggers” that cancel instance goals), and ordering relations (“precedes” relations that force certain goals to be achieved before others).

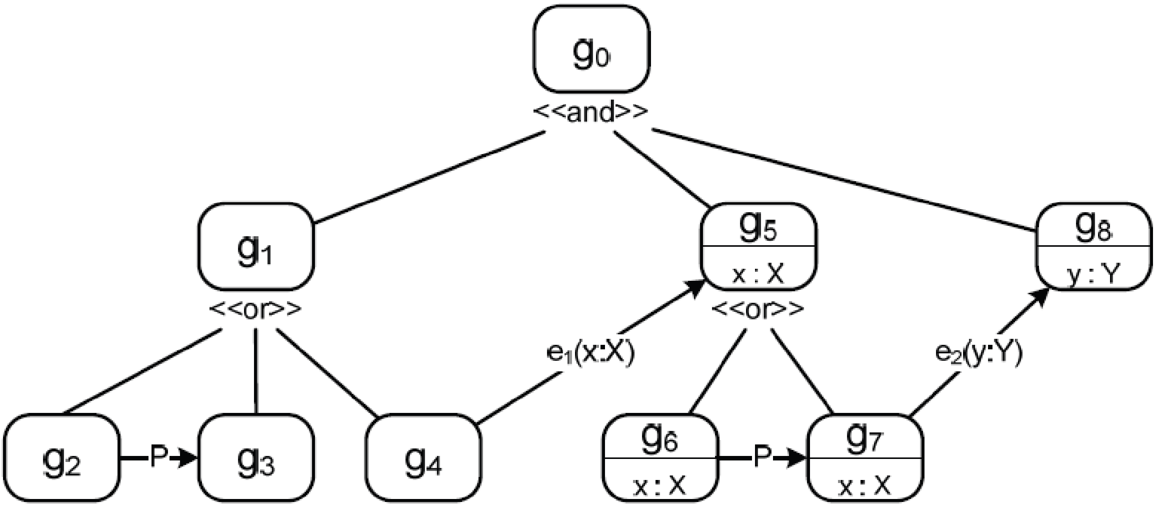


Figure 1 GMoDS Specification Goal Tree [1]

The GMoDS instance goal tree represents run time instances of the specification goal templates, with any template parameters instantiated with values. See Figure 2 [2] below. Instance goals are created in response to events that occur during execution of tasks that fulfill goals and as a result of the relationships specified in the goal specification tree. A special "init event" bootstraps the system, creating the initial instance goals that have no other trigger specified. An instance goal tree represents parent/child relationships and can be color coded to represent the status of a goal (triggered, active, achieved, failed, removed, or obviated) (see 0 below, terms and definitions, for explanation of these statuses).

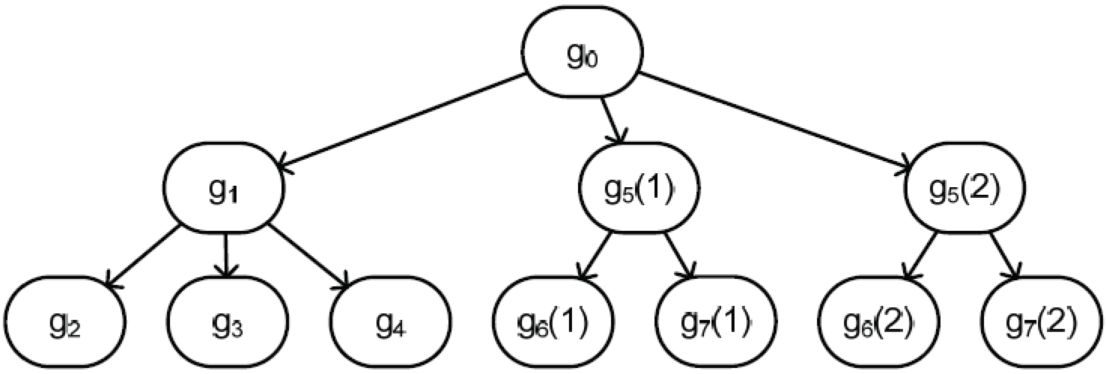


Figure 2 GMoDS Instance Goal Tree [1]

1.1.3 Terms and Definitions

- Instance goal state – the state of the instance goal within GMoDS (one of triggered, active, achieved, failed, removed, or obviated).
- Triggered – a goal is triggered by the "init event" if it has no other trigger. Otherwise, the event associated with a "triggers" relation must occur while a task associated with the

goal at the source of the triggers relation is being executed for the goal to become triggered.

- Active – a goal becomes active if it is triggered and no precedes relation exists that points to the triggered goal (or its ancestors) from an unachieved goal.
- Achieved – a leaf goal is achieved when the agent executing the goal notifies GMoDS of its achievement. A parent of child goals joined by “AND” is achieved when all of its child goals are achieved. A parent of child goals joined by “OR” is achieved if any of its child goals are achieved.
- Failed – a leaf goal enters the failed status if the agent executing it notifies GMoDS of failure to fulfill it.
- Removed – a goal is removed from the instance tree as if it never existed if the event associated with a negative trigger occurs during the execution of the goal that is the source of the negative trigger and that trigger points to the specification goal that is the template for the removed instance goal.
- Obviated – a goal is obviated (made unnecessary to successful completion of its parent goal) if a sibling goal is achieved when those siblings are connected by OR to their parent goal.
- Parameter value origin – the means by which the parameter value was established in GMoDS (one of inherited, trigger, or modification). An inherited value comes from its parent goal. A value with origin trigger comes from the triggering event. The origin “modification” indicates the parameter value was modified.

1.2 Project Overview

1.2.1 Project Goal

The goal of this project is to provide an optional GMoDS run time information visualizer that can be tested by multiple means. An additional project goal is to provide a GMoDS test driver component that can test the visualizer by directly stimulating GMoDS substituting for a simulation application component.

1.2.2 System Context

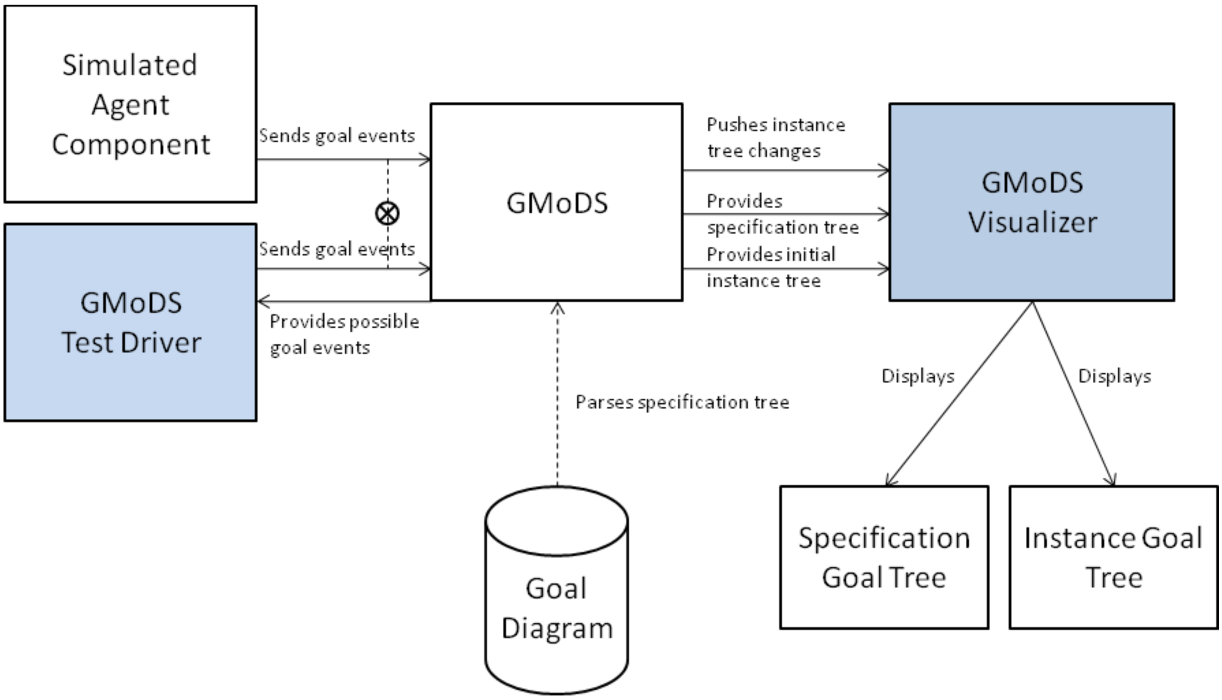

Simulated Agent Component
Sends goal events
GMoDS Test Driver
Sends goal events
Provides possible goal events
GMoDS
Pushes instance tree changes
Provides specification tree
Provides initial instance tree
GMoDS Visualizer
Parses specification tree
Displays
Displays
Goal Diagram
Specification Goal Tree
Instance Goal Tree

Figure 3 GMoDS Visualization Project System Context

Figure 3 above shows the system context for the components developed in this project. The project goal is to develop the GMoDS Test Driver and GMoDS Visualizer components shown shaded in light blue in this figure.

The figure shows that either the GMoDs Test Driver or a simulated agent component (but not both) send goal events to GMoDS. GMoDS provides the possible goal events to the GMoDS Test Driver. GMoDS pushes instance tree changes to the GMoDS Visualizer using a variant of the Observer design pattern called ChangeManager. GMoDS already implements the client portion of this design pattern. The GMoDS component provides the specification goal tree and initial instance goal tree to the GMoDS Visualizer. The GMoDS Visualizer uses the specification goal tree and instance goal tree as part of the “model” for its Model/View/Controller architecture. The GMoDs Visualizer will display the specification goal tree and initial instance tree and await changes from GMoDS. The GMoDS Visualizer will not import any layout information from the goal diagram since GMoDS goal models can be programmatically built rather than through parsing a goal diagram.

GMoDS Test Driver relies on GMoDS to define the possible goal events in order to issue random goal events. In addition, the GMoDS Test Driver can check user-provided event scripts for legality using GMoDS interfaces.

GMoDS parses the goal model diagram, if the specification tree is not programmatically built.

1.3 Project Requirements

1.3.1 GMoDS Test Driver

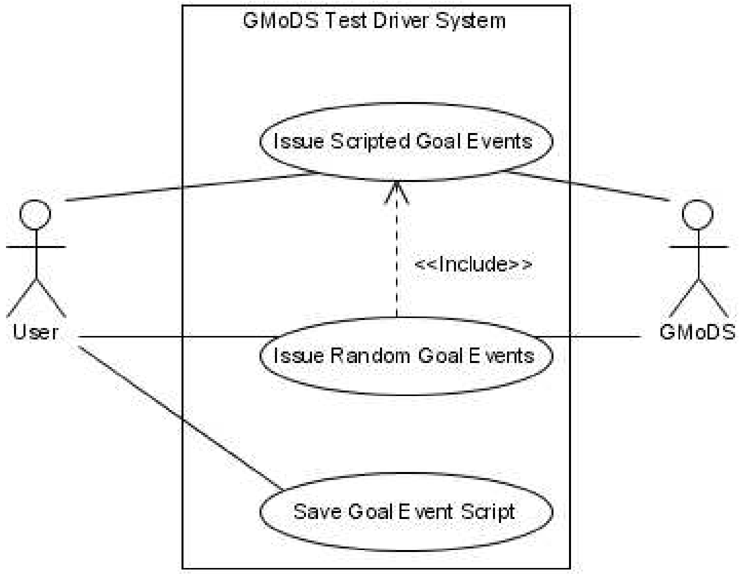


Figure 4 GMoDS Test Driver Use Cases

Figure 4 above shows use cases for the GMoDS Test Driver. When invoking the GMoDS Test Driver, the user specifies the goal diagram that will be passed to GMoDS to build the specification goal tree. The GMoDS Test Driver instantiates the GMoDS component, populates the specification tree, and initializes the instance goal tree. The GMoDS Test Driver then constructs the GMoDS Visualizer passing in a reference to the GMoDS component and to itself. The reference to the GMoDS Test Driver causes the GMoDS Visualizer to add UI components to control the GMoDS Test Driver.

1.3.1.1 Use Case GTD-1 Issue Scripted Goal Events

1.3.1.1.1 Description

The user selects “Load Event Script”. The GMoDS Test Driver prompts the user to provide a goal event script that defines the goal events that will be issued to GMoDS and the delay time between these events. It is the user’s responsibility to assure that the goal events are consistent with the goal diagram but the GMoDS Test Driver will check the script for correct event and parameter names. Upon initialization, the GMoDS Test Driver enters manual mode and waits for user interaction. If the user clicks “Play”, the GMoDS Test Driver enters automatic mode and executes the goal event script pausing for the specified delay time between events. If the user clicks “Pause” in automatic mode, the GMoDS Test Driver event execution pauses and the GMoDS Test Driver enters manual mode. If the user clicks “Next” in manual mode, the next event is executed. The goal events are issued to the GMoDS component which alters the instance tree based on the event and specification tree definition and informs the GMoDS Visualizer.

1.3.1.1.2 Associated Functional Requirements

1.3.1.1.2.1 SR.GTD-1.1(Non-critical Requirement)

The GMoDS Test Driver shall prompt the user for a goal event script if the user selects “Load Event Script” and if such a script is provided, the GMoDS Test Driver shall enter scripted event mode (“Use Case GTD-1 Issue Scripted Goal Events”).

1.3.1.1.2.2 SR.GTD-1.2 (Critical Requirement)

The GMoDS Test Driver shall parse the goal event script to generate goal events, their parameters, and the time delay relative to the previous goal event.

1.3.1.1.2.3 SR.GTD-1.2.1(Non-critical Requirement)

The GMoDS Test Driver shall log errors and drop the corresponding goal event from the script if a goal event or parameter name does not match a legal name defined in the goal diagram. In addition, the GMoDS Test Driver shall visually inform the user of these errors.

1.3.1.1.2.4 SR.GTD-1.2.2 (Critical Requirement)

The GMoDS Test Driver shall support a scripted events language with the following event types: ACHIEVED, FAILED, and MODIFIED events for each active instance goal, and positive and negative trigger events defined by the specification goal corresponding to any active instance goal.

1.3.1.1.2.5 SR.GTD-1.2.3 (Critical Requirement)

The GMoDS Test Driver Event Script Language (GTD-ESL) shall include the following XML elements and attributes as shown in Figure 5 below and defined in the following requirements.

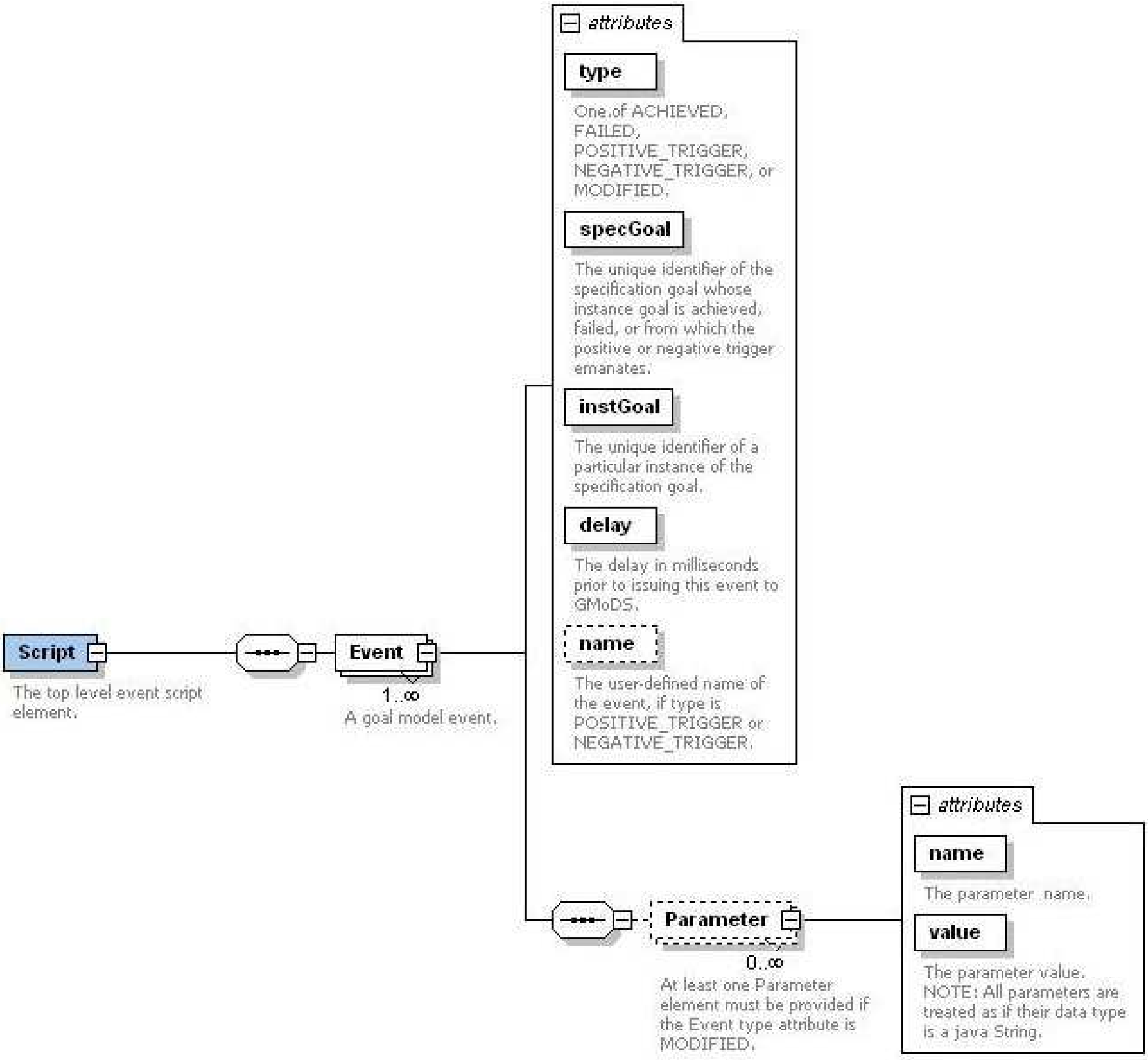

attributes
type
One of ACHIEVED, FAILED, POSITIVE_TRIGGER, NEGATIVE_TRIGGER, or MODIFIED.
specGoal
The unique identifier of the specification goal whose instance goal is achieved, failed, or from which the positive or negative trigger emanates.
instGoal
The unique identifier of a particular instance of the specification goal.
delay
The delay in milliseconds prior to issuing this event to GMoDS.
name
The user-defined name of the event, if type is POSITIVE_TRIGGER or NEGATIVE_TRIGGER.
Script
The top level event script element.
Event
1..∞
A goal model event.
attributes
name
The parameter name.
value
The parameter value. NOTE: All parameters are treated as if their data type is a java String.
Parameter
0..∞
At least one Parameter element must be provided if the Event type attribute is MODIFIED.

Figure 5 GMoDS Test Driver Event Script Language

1.3.1.1.2.5.1 SR.GTD-1.2.3.1 (Critical Requirement)

The GTD-ESL shall have a top-level “Script” element containing one or more “Event” element children.

1.3.1.1.2.5.2 SR.GTD-1.2.3.2 (Critical Requirement)

The GTD-ESL “Event” element shall represent a single goal model event and have the following attributes: “type” whose possible values are ACHIEVED, FAILED, POSITIVE_TRIGGER, NEGATIVE_TRIGGER, or MODIFIED, “specGoal” whose value is the unique identifier of the specification goal whose instance goal is achieved, failed, or from which the positive or negative trigger emanates, “instGoal” whose value is the unique integer identifier of a particular instance of the specification goal, “delay” whose value is the delay in milliseconds prior to issuing this event to GMoDS (with minimum acceptable value of 1), and “name” whose value is the user-defined event name if the “type” is POSITIVE_TRIGGER or NEGATIVE_TRIGGER. If “type” is MODIFIED, “instGoal” is the goal whose parameters are modified.

1.3.1.1.2.5.3 SR.GTD-1.2.3.3 (Critical Requirement)
The GTD-ESL “Event” element attributes “type”, “specGoal”, “instGoal”, and delay must be provided.

1.3.1.1.2.5.4 SR.GTD-1.2.3.4 (Critical Requirement)
The GTD-ESL “Event” element attribute “name” must be provided if “type” has value POSITIVE_TRIGGER or NEGATIVE_TRIGGER.

1.3.1.1.2.5.5 SR.GTD-1.2.3.5 (Critical Requirement)
The GTD-ESL “Event” element shall contain 0 or more “Parameter” element children.

1.3.1.1.2.5.6 SR.GTD-1.2.3.6 (Critical Requirement)
The GTD-ESL “Parameter” element shall represent the parameters of a positive or negative trigger or “modifyInstanceGoal” event and have the following attributes: “name” whose value is the parameter name and “value” whose value is the parameter value.

1.3.1.1.2.5.7 SR.GTD-1.2.3.7 (Critical Requirement)
The GTD-ESL “Parameter” element “value” attribute shall be treated as if the parameter’s data type is a Java String.

1.3.1.1.2.5.8 SR.GTD-1.2.3.8 (Critical Requirement)
At least one GTD-ESL “Parameter” element must be provided if “type” is MODIFIED.

1.3.1.1.2.6 SR.GTD-1.3(Critical Requirement)

The GMoDS Test Driver shall cause GMoDS to populate its specification goal tree.

1.3.1.1.2.7 SR.GTD-1.4(Critical Requirement)

The GMoDS Test Driver shall cause GMoDS to initialize its instance goal tree.

1.3.1.1.2.8 SR.GTD-1.5(Critical Requirement)

The GMoDS Test Driver shall issue each goal event defined in the event script to GMoDS after the specified delay time (milliseconds) relative to the previously issued goal event.

1.3.1.1.2.9 SR.GTD-1.6 (Critical Requirement)

Upon initialization of the GMoDS Test Driver in this use case, the GMoDS Test Driver shall enter manual mode and await user interaction.

1.3.1.1.2.10 SR.GTD-1.6.1 (Critical Requirement)

If the user clicks “Play” in manual mode, the GMoDS Test Driver enters automatic mode and begins to execute each event as defined in 1.3.1.1.2.8 above. If GMoDS Test Driver is in random event operation, GMoDS Test Driver automatically generates a new random event and executes it after the random delay time until the specified number of random events has been issued.

1.3.1.1.2.11 SR.GTD-1.6.2 (Critical Requirement)

If the user clicks “Next” in manual mode, the GMoDS Test Driver issues the next unexecuted goal event and waits for the next user interaction. If GMoDS Test Driver is in random event operation and manual mode, the GMoDS Test Driver generates the next random event, appends it to the currently executing script, issues the event to GMoDS, and waits for the next user interaction.

1.3.1.1.2.12 SR.GTD-1.6.3 (Critical Requirement)

If the user clicks “Pause” in automatic mode, the GMoDS Test Driver enters manual mode and waits for the next user interaction.

1.3.1.1.2.13 SR.GTD-1.6.4 (Critical Requirement)

If there are no more pre-defined events remaining or the specified number of random events have been issued, the GMoDS Test Driver disables the “Play” and “Next” controls.

1.3.1.2 Use Case GTD-2 Issue Random Goal Events

Table 1 below shows GMoDS Test Driver options to configure random events.

Table 1 GMoDS Test Driver Random Event Options

Option	Definition	Default	Modified
Min String Length	Minimum length for a String representing a parameter value.	1	While paused or in manual mode.
Max String Length	Maximum length for a String representing a parameter value.	10	While paused or in manual mode.
Min Delay Time	Minimum delay time between events.	$Flash\ Period +$ 1000 milliseconds (see Table 2 page 17)	While paused or in manual mode.
Max Delay Time	Maximum delay time between events.	$Flash\ Period\ \times 2$ milliseconds (see Table 2 page 17)	While paused or in manual mode.
Number of Random Events	The total number of random events to issue.	25	While paused or in manual mode.

1.3.1.2.1 Description

The user selects "Issue Random Events". The GMoDS Test Driver replaces the currently loaded event script with an empty script and begins random goal event generation. The GMoDS Test Driver relies on the GMoDS component to discover the possible goal events based on the events that have been issued to GMoDS. The "init" event provides the initial set of active instance goals. The GMoDS Test Driver generates a random event as specified in the random event configuration based on the current active instance goals and appends this event to the currently executing event script. The GMoDS Test Driver issues the last-generated event to GMoDS, according to "1.3.1.1.2.8 and 1.3.1.1.2.9" described above, after a random delay time, if GMoDS Test Driver is in automatic mode or immediately if in manual mode. Upon execution of that event, the "Use Case GTD-2 Issue Random Goal Events" resumes event generation until the final random event is issued. The GMoDS Test Driver keeps the currently executing goal event script which can be saved using the "Use Case GTD-3 Save Goal Event Script" described below. Each active instance goal's specification goal defines the positive and negative trigger events that can be executed from that goal. In addition, the GMoDS Test Driver can issue an ACHIEVED, FAILED, or MODIFIED event for each active instance goal. The union of all positive and negative trigger, ACHIEVED, FAILED, and MODIFIED events defined by all active instance goals and their corresponding specification goals defines the possible random events at any time.

1.3.1.2.2 Associated Functional Requirements

1.3.1.2.2.1 SR.GTD-1.1

See 1.3.1.1.2.1 above.

1.3.1.2.2.1.1 SR.GTD.2.1.1 (Non-critical Requirement)
The GMoDS Test Driver shall treat all parameter types as if they were String. That is, the system shall make no attempt to generate a value of the type specified for the parameter in the goal diagram. Instead, the type of the java object will be String for all parameter values. The system will generate a random String for each parameter value.

1.3.1.2.2.1.2 SR.GTD.2.1.2 (Non-critical Requirement)
The GMoDS Test Driver may be configured with the minimum and maximum string lengths for randomly generated strings. The system shall default to a minimum string length of 1 and a maximum string length of 10.

1.3.1.2.2.1.3 SR.GTD.2.1.3 (Non-critical Requirement)
The GMoDS Test Driver may be configured with the minimum and maximum delay time in milliseconds between randomly issued goal events. The system shall default to a minimum delay time and maximum delay time defined relative to the default "Flash Period" from Table 2 on page 17. The minimum delay time shall default to the default "Flash Period" plus 1000 milliseconds. The maximum delay time shall default to twice the default "Flash Period". The system shall not accept a minimum delay time of less than the current "Flash Period" plus 100 milliseconds.

1.3.1.2.2.1.4 SR.GTD.2.1.4 (Non-critical Requirement)
The GMoDS Test Driver may be configured with the number of random goal events to issue. The system will default to 25 random goal events to issue.

1.3.1.2.2.2 SR.GTD-1.3

See 1.3.1.1.2.6 above.

1.3.1.2.2.3 SR.GTD-1.4

See 1.3.1.1.2.7 above.

1.3.1.2.2.4 SR.GTD-2.2 (Critical Requirement)

The GMoDS Test Driver shall incrementally issue random goal events based on the current active instance goals. The union of all positive and negative trigger, ACHIEVED, FAILED, and MODIFIED events defined by all active instance goals and their corresponding specification goals defines the possible random events at any time.

1.3.1.2.2.5 SR.GTD-2.3 (Critical Requirement)

The GMoDS Test Driver shall keep a history of randomly-generated goal events to form the current event script being executed.

1.3.1.3 Use Case GTD-3 Save Goal Event Script

1.3.1.3.1 Description

The user selects "Save Script" and is prompted for a file in which to save the current goal event script. If the user selects a file that exists, the GMoDS Test driver asks for confirmation that it should overwrite that file. If the user selects a file name that does not exist or confirms the overwrite operation, the GMoDS Test Driver saves the current goal event script to the file.

1.3.1.3.2 Associated Functional Requirements

1.3.1.3.2.1 SR.GTD-3.1 (Non-critical Requirement)

The GMoDS Test Driver shall provide a "Save Script" menu item that will cause the GMoDS Test Driver to save the currently executing goal event script to a file.

1.3.1.3.2.2 SR.GTD-3.2 (Non-critical Requirement)

The GMoDS Test Driver shall allow the user to specify the file to contain the saved script.

1.3.1.3.2.3 SR.GTD-3.2.1 (Non-critical Requirement)

If the user selects a file that exists, the GMoDS Test driver shall ask for confirmation that it should overwrite that file.

1.3.1.3.2.4 SR.GTD-3.2.2 (Non-critical Requirement)

If the user selects a file name that does not exist or confirms the overwrite operation, the GMoDS Test Driver shall save the current goal event script to the file.

1.3.2 GMoDS Visualizer

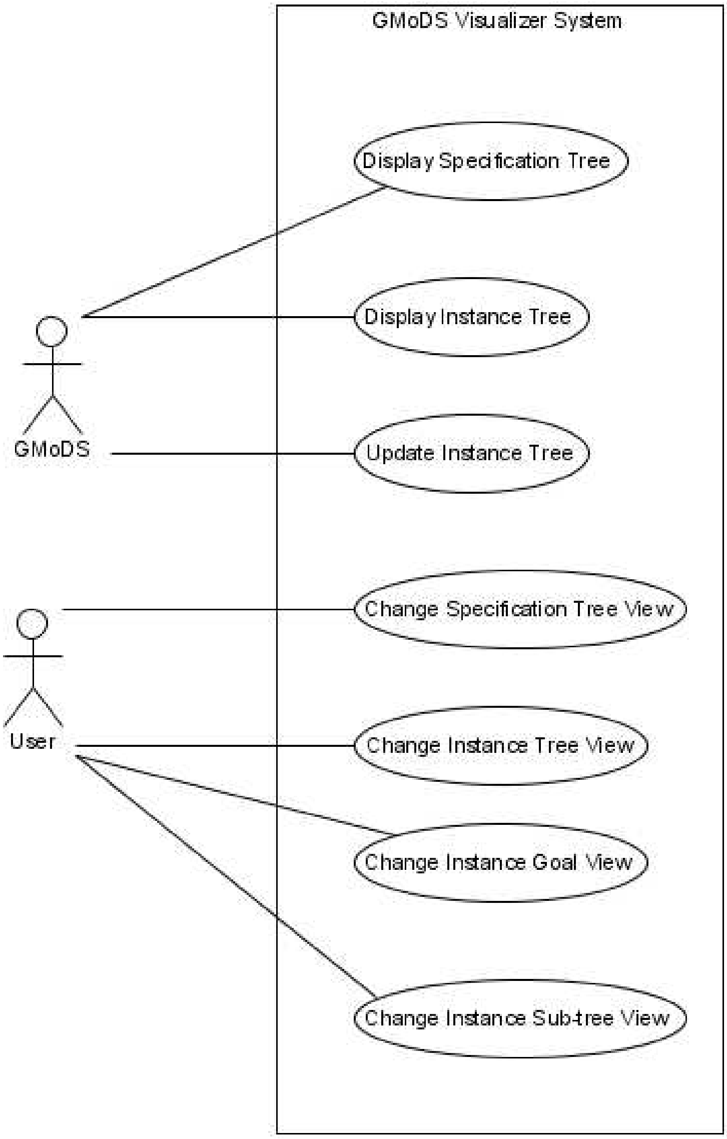

GMoDS Visualizer System
Display Specification Tree
Display Instance Tree
Update Instance Tree
Change Specification Tree View
Change Instance Tree View
Change Instance Goal View
Change Instance Sub-tree View
GMoDS
User

Figure 6 GMoDS Visualizer Use Cases

Figure 6 above shows use cases for the GMoDS Visualizer. The client component (simulated agent component or GMoDS Test Driver) instantiates the GMoDS component, populates the specification tree, and initializes the instance goal tree. The client component then constructs the GMoDS Visualizer passing in a reference to the GMoDS component. The GMoDS Visualizer registers itself with GMoDS' EventRegistry as the ChangeManager. The GMoDS Visualizer displays the specification goal tree pulled from the GMoDS component. The GMoDS Visualizer displays the initial instance goal tree provided by GMoDS and changes to the instance goal tree pushed to it by GMoDS. The User can alter the appearance of the specification goal tree or instance goal tree as a whole, change the appearance of a specific instance goal, or collapse/expand a sub-tree of instance goals. Table 2 below shows the GMoDS Visualizer options.

Table 2 GMoDS Visutalizer Options

Option	Definition	Default	Modified
Flash Period	Total time a changed instance goal is flashed.	2 seconds	In manual mode.
Flash Cycle	Time between instance goal color inversions in a single flash.	0.5 seconds	In manual mode.
Specification Tree Show/Hide Parameters	Show or hide parameter names and types throughout the specification goal tree.	Show	At run-time.
Instance Tree Show/Hide Parameters	Show or hide parameter names, values, and origin throughout the entire instance goal tree.	Show	At run-time.
Show/Hide Instance Goals of Particular Specification Goals	Show or hide particular specification goals' derived instance goals (a check list of goal types to show is presented to the user).	Show	At run-time.
Triggered Goal Background	A triggered goal's background color.	□	At run-time.
Triggered Goal Foreground	A triggered goal's foreground color.	■	At run-time.
Triggered Goal Flash Background	A triggered goal's background color during a flash.	□	At run-time.
Triggered Goal Flash Foreground	A triggered goal's foreground color during a flash.	🟪	At run-time.
Active Goal Background	An active goal's background color.	🟦	At run-time.
Active Goal Foreground	An active goal's foreground color.	■	At run-time.
Active Goal Flash Background	An active goal's background color during a flash.	□	At run-time.
Active Goal Flash Foreground	An active goal's foreground color during a flash.	■	At run-time.
Achieved Goal Background	An achieved goal's background color.	🟩	At run-time.
Achieved Goal Foreground	An achieved goal's foreground color.	■	At run-time.
Achieved Goal Flash Background	An achieved goal's background color during a flash.	□	At run-time.
Achieved Goal Flash Foreground	An achieved goal's foreground color during a flash.	■	At run-time.
Failed Goal Background	A failed goal's background color.	🟥	At run-time.
Failed Goal Foreground	A failed goal's foreground color.	■	At run-time.
Failed Goal Flash Background	A failed goal's background color during a flash.	□	At run-time.
Failed Goal Flash Foreground	A failed goal's foreground color during a flash.	■	At run-time.
Removed Goal Background	A removed goal's background color.	▒	At run-time.
Removed Goal Foreground	A removed goal's foreground color.	□	At run-time.

Option	Definition	Default	Modified
Removed Goal Flash Background	A removed goal’s background color during a flash.	□	At run-time.
Removed Goal Flash Foreground	A removed goal’s foreground color during a flash.	■	At run-time.
Obviated Goal Background	An obviated goal’s background color.	▨	At run-time.
Obviated Goal Foreground	A removed goal’s foreground color.	□	At run-time.
Obviated Goal Flash Background	A removed goal’s background color during a flash.	□	At run-time.
Obviated Goal Flash Foreground	A removed goal’s foreground color during a flash.	▨	At run-time.

1.3.2.1 Use Case GV-1 Display Specification Tree

1.3.2.1.1 Description

The GMoDS Visualizer displays the specification tree including all goals, parent/child relations, positive trigger relations, negative trigger relations, and precedes relations with their string identifiers. The system uses the current setting for “Specification Tree Show/Hide Parameters” to decide whether goal, positive trigger, and negative trigger parameter names and types are shown. The default setting causes the system to display these parameters and types. See Figure 7 below.

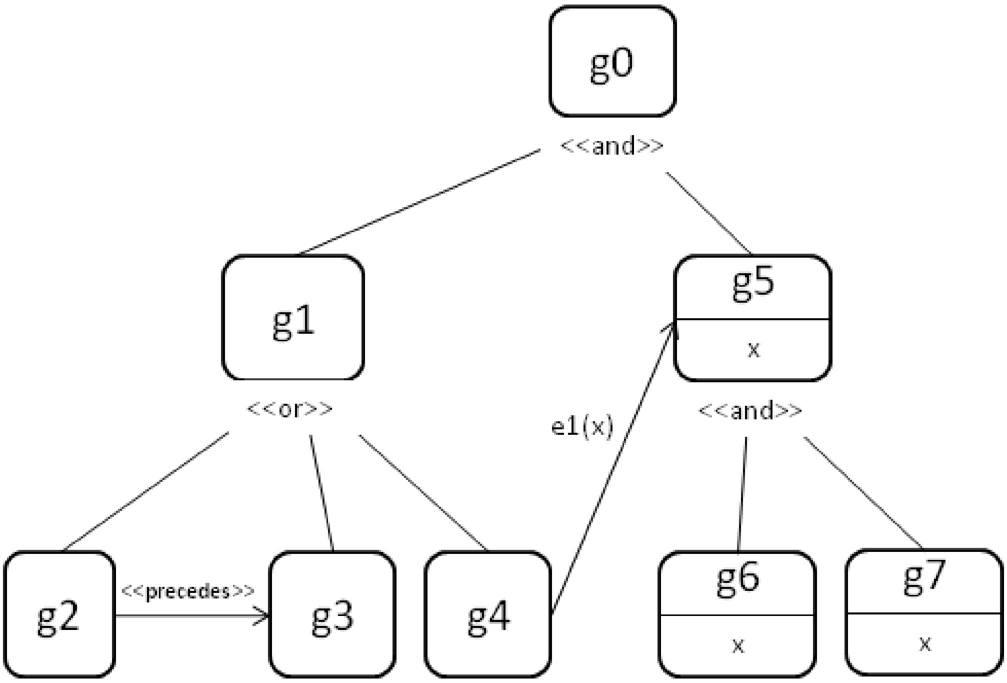


Figure 7 Use Case GV-1

1.3.2.1.2 Associated Functional Requirements

1.3.2.1.2.1 SR.GV-1.1(Critical Requirement)

The system shall display the specification goal tree as a graphical tree using minimum white space padding between adjacent tree elements. Each goal will have a white background and black foreground lines and characters.

1.3.2.1.2.2 SR.GV-1.2 (Critical Requirement)

The system shall display the string name of all specification goals, parent/child connectives («and» and «or»), trigger events, negative trigger events, and precedes relations («precedes»).

1.3.2.1.2.3 SR.GV-1.3(Non-critical Requirement)

The system shall use the current “Specification Tree Show/Hide Parameters” setting to decide whether to display the parameter name for goals or events.

1.3.2.1.2.4 SR.GV-1.4(Critical Requirement)

The system shall show all parent/child, precedes, positive trigger, and negative trigger relations as lines connecting two specification goals.

1.3.2.1.2.5 SR.GV-1.5(Critical Requirement)

The lines connecting the source specification goal to the destination specification goal for positive trigger, negative trigger, and precedes relations shall have an arrow head pointing to the destination goal.

1.3.2.1.2.6 SR.GV-1.6(Critical Requirement)

Parent/child, precedes, and trigger relation lines shall be solid.

1.3.2.1.2.7 SR.GV-1.7(Critical Requirement)

Negative trigger relation lines shall be dashed.

1.3.2.1.2.8 SR.GV-1.8(Non-critical Requirement)

The system shall separate specification goal names from parameters using a horizontal line if parameters are displayed. If parameters are not displayed no such horizontal line shall be shown.

1.3.2.1.2.9 SR.GV-1.9(Non-critical Requirement)

The system shall show for each specification goal each parameter name on its own single separate line.

1.3.2.1.2.10 SR.GV-1.10(Non-critical Requirement)

The system shall show all event parameters on a single line between the opening parenthesis and closing parenthesis separated by a comma. The final parameter shall be followed by the closing parenthesis and no comma.

1.3.2.1.2.11 SR.GV-1.11(Critical Requirement)

Parent/child relation lines shall not intersect with each other.

1.3.2.1.2.12 SR.GV-1.12(Non-critical Requirement)

The system shall minimize the number of intersections between precedes, positive trigger, negative trigger, and parent/child relation lines.

1.3.2.1.2.13 SR.GV-1.13(Critical Requirement)

The system shall not allow any lines to intersect goal rectangles.

1.3.2.1.2.14 SR.GV-1.14(Critical Requirement)

The system shall provide scrolling and zooming of the specification goal tree view.

1.3.2.2 Use Case GV-2 Display Instance Tree

1.3.2.2.1 Description

The GMoDS Visualizer displays the initial instance goal tree in a tree-like structure including all instance goals, and parent/child relations with their string identifiers. By default, goal parameter names, values, and the values' origin (I – inherited, T – trigger, M – modification) are shown. The system shows each instance goal state visually. See Figure 8 below.

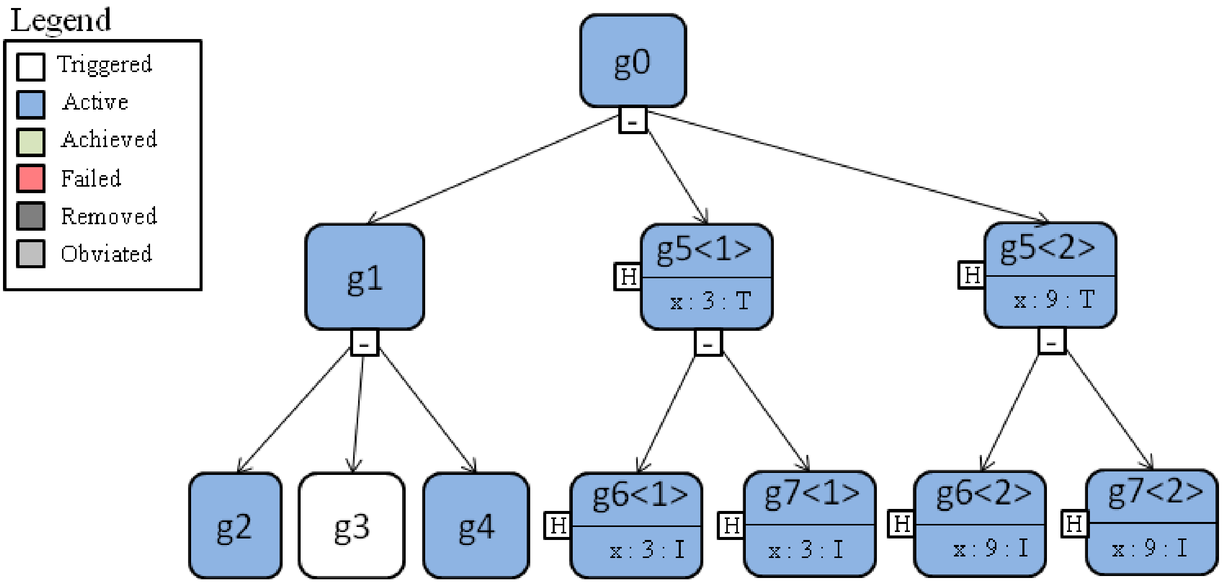


Figure 8 Use Case GV-2

1.3.2.2.2 Associated Functional Requirements

1.3.2.2.2.1 SR.GV-2.1(Critical Requirement)

The system shall display the instance goal tree as a graphical tree using minimum white space padding between adjacent tree elements. Each instance goal will have a background color that indicates the current state of the instance goal and black foreground lines and characters. The state colors shall be as indicated in the "Legend" in Figure 8 above by default but shall be editable at run time.

1.3.2.2.2.2 SR.GV-2.2(Critical Requirement)

The system shall display the instance goal name for each instance goal.

1.3.2.2.2.3 SR.GV-2.3(Non-critical Requirement)

The system shall display a collapse/expand toggle rectangle, if the instance goal has children, centered on the lower edge of the instance goal. An instance goal displaying its children will display the character "-" in the collapse/expand toggle. An instance goal hiding its children will display "+" in the collapse/expand toggle.

1.3.2.2.2.4 SR.GV-2.4(Non-critical Requirement)

The system shall display a show/hide parameter toggle rectangle, if the instance goal has parameters, centered on the left edge of the instance goal. An instance goal showing its parameters will display the character "H" in the show/hide parameter toggle. An instance goal hiding its parameters will display the character "S" in the show/hide parameter toggle.

1.3.2.2.2.5 SR.GV-2.5(Critical Requirement)

The system shall connect each parent instance goal to one of its child instance goals using a line with an arrow pointing to the child, whose source is the collapse/expand toggle control on the parent instance goal. The arrow head shall be centered on the top edge of the child instance goal.

1.3.2.2.2.6 SR.GV-2.6(Non-critical Requirement)

The system shall separate instance goal names from parameters using a horizontal line if parameters are displayed. If parameters are not displayed no such horizontal line shall be shown.

1.3.2.2.2.7 SR.GV-2.7 (Non-critical Requirement)

The system shall show each instance goal parameter, parameter value, and parameter value origin combination on a single line separated by a space, a semi-colon, and another space. One line will be used for each combination of instance goal parameter, parameter value, and parameters value origin.

1.3.2.2.2.8 SR.GV-2.8(Non-critical Requirement)

The system shall abbreviate the parameter value origin values as I (inherited), T (trigger), and M (modification).

1.3.2.2.2.9 SR.GV-2.9(Critical Requirement)

The system shall provide scrolling and zooming of the instance goal tree view.

1.3.2.2.2.10 SR.GV-2.10 (Non-critical Requirement)

The system shall allow the user to specify that instance goals of particular specification goals be shown or hidden.

1.3.2.2.2.11 SR.GV-1.11

See 1.3.2.1.2.11 above.

1.3.2.2.2.12 SR.GV-1.13

See 1.3.2.1.2.13 above

1.3.2.3 Use Case GV-3 Update Instance Tree

1.3.2.3.1 Description

The system receives notification from GMoDS that some aspect of the instance tree has changed. The system modifies the display to reflect the changed information and flashes the affected instance goals for a pre-determined period.

1.3.2.3.2 Associated Functional Requirements

1.3.2.3.2.1 SR.GV-3.1 (Critical Requirement)

The system shall flash all instance goals for which it has received a change for a pre-defined period.

1.3.2.3.2.2 SR.GV-3.2 (Non-critical Requirement)

The default flashing period shall be 2 seconds. The default flashing cycle shall be 0.5 second. Both the flashing period and flashing cycle shall be editable in manual mode.

1.3.2.3.2.3 SR.GV-3.3 (Critical Requirement)

The system shall flash an instance goal by changing its background and foreground from its state color to its defined flash color and back once every flashing cycle. The user may avoid the flashing effect by making the state and flash background and foreground colors match.

1.3.2.4 Use Case GV-4 Change Specification Tree View

1.3.2.4.1 Description

The user changes the display of parameters throughout the specification goal tree by selecting hide or show parameters from a menu bar menu item. All specification goal and event - parameters are hidden or shown as specified by the user. The system minimizes the display area consumed by the tree at all times. The system reduces the size of elements that include parameters when the parameters are hidden and expands the elements when parameters are shown. See Figure 9 below and compare with Figure 7 above.

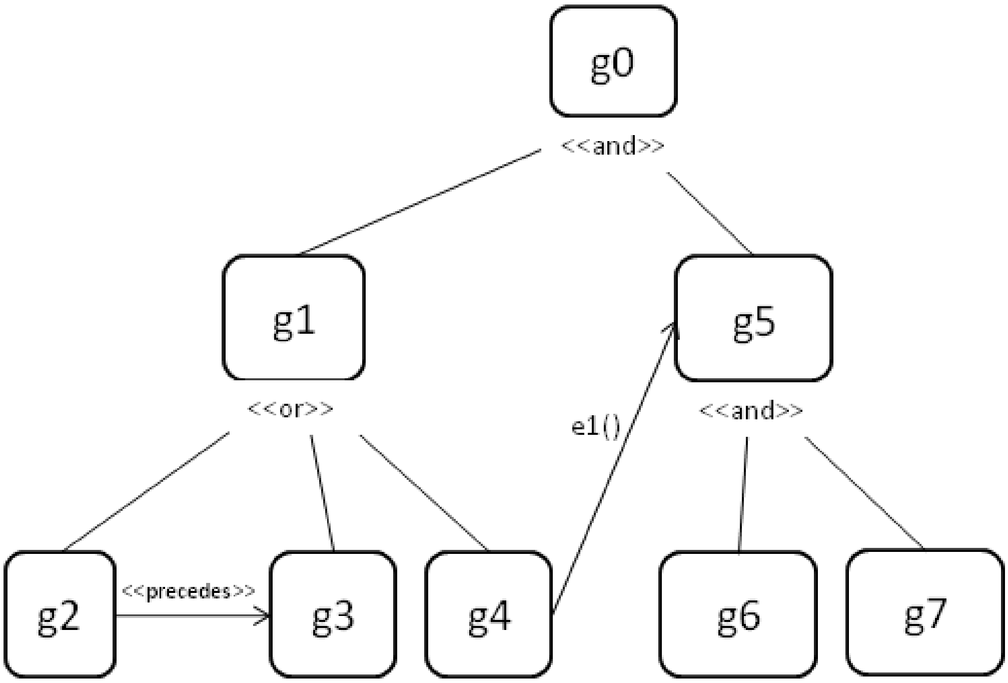


Figure 9 Use Case GV-4

1.3.2.4.2 Associated Functional Requirements

1.3.2.4.2.1 SR.GV-4.1(Non-critical Requirement)

The system shall show or hide all specification goal and event parameters as specified by the user.

1.3.2.4.2.2 SR.GV-1.8

See 1.3.2.1.2.8 above.

1.3.2.4.2.3 SR.GV-1.9

See 1.3.2.1.2.9 above.

1.3.2.5 Use Case GV-5 Change Instance Tree View

1.3.2.5.1 Description

The user changes the display of parameters, their values, and the values’ origin throughout the instance goal tree by selecting hide or show parameters from a menu bar menu item. All instance goal parameters are hidden or shown as specified by the user. The system minimizes the display area consumed by the tree at all times. The system reduces the size of elements that include parameters when the parameters are hidden and expands the elements when parameters are shown. See Figure 10 below and compare with Figure 8 above.

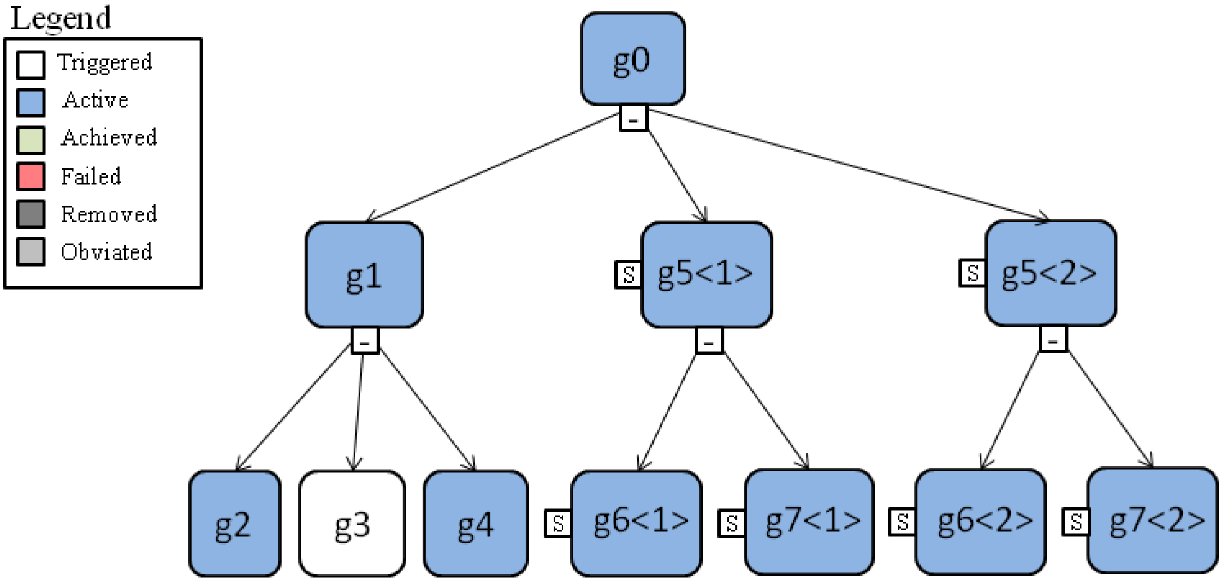


Figure 10 Use Case GV-5

1.3.2.5.2 Associated Functional Requirements

1.3.2.5.2.1 SR.GV-5.1(Non-critical Requirement)

The system shall show or hide all instance goal parameters as specified by the user.

1.3.2.5.2.2 SR.GV-2.6

See 1.3.2.2.2.6 above.

1.3.2.5.2.3 SR.GV-2.7

See 1.3.2.2.2.7 above.

1.3.2.6 Use Case GV-6 Change Instance Goal View

1.3.2.6.1 Description

The user toggles the display of parameters, their values, and the values' origin for a specific instance goal. The user clicks the view toggle control (a rectangle enclosing the letter S or H) on a specific instance goal to toggle the display of parameters, their values, and the values' origin. The system minimizes the display area consumed by the tree at all times. The system reduces the size of elements that include parameters when the parameters are hidden and expands the elements when parameters are shown. See Figure 11 below where goal g5<2>'s parameters have been hidden.

1.3.2.6.2 Associated Functional Requirements

1.3.2.6.2.1 SR.GV-6.1(Non-critical Requirement)

The system shall toggle the display of parameter names, value, and value origins for the specific instance goal whose parameter display toggle control has been clicked.

1.3.2.7 Use Case GV-7 Change Instance Sub-tree View

1.3.2.7.1 Description

The user collapses or expands a specific instance goal sub-tree by clicking on its expand/collapse toggle. When the system collapses a sub-tree it consumes less space in the display area. The system redraws the instance tree with child elements of the specified goal removed if the instance goal sub-tree is collapsed. A collapsed sub-tree draws its' expand/collapse toggle as "+". An expanded sub-tree draws its' expand/collapse toggle as "-". A minimum white space pad surrounds each visible instance goal, placing collapsed instance goal sub-trees as near as possible to their peer instance goals. See Figure 11 below, where goal g5<2>'s sub-tree is collapsed.

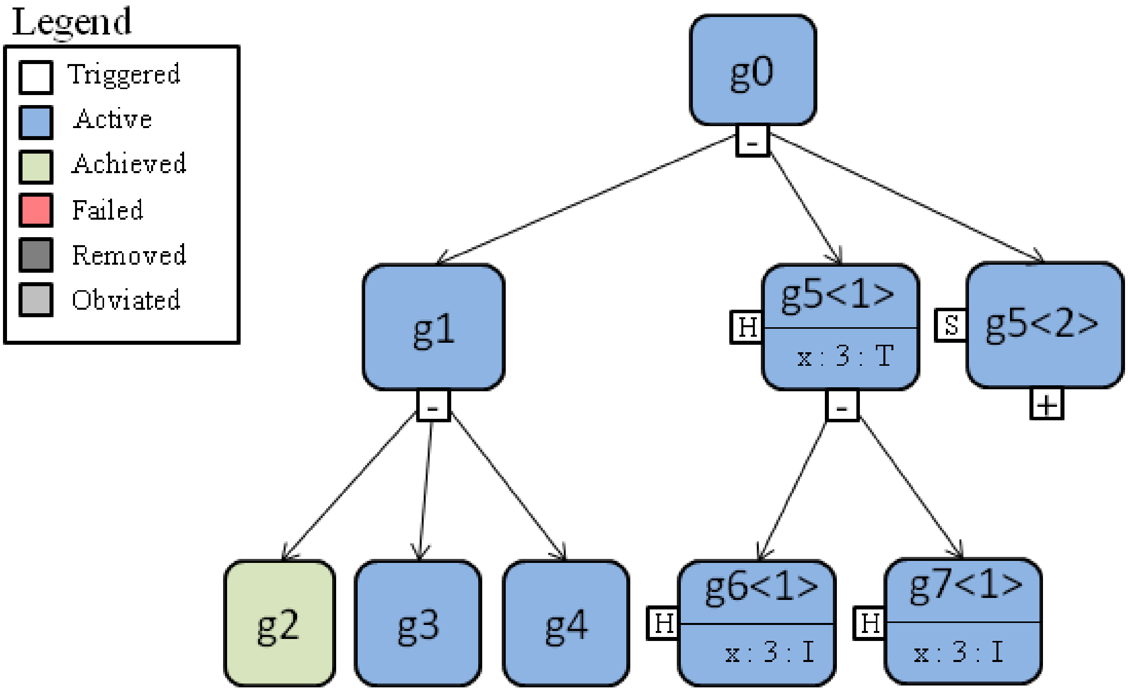


Figure 11 Use Cases GV-6 and GV-7

1.3.2.7.2 Associated Functional Requirements

1.3.2.7.2.1 SR.GV-7.1(Non-critical Requirement)

The system shall collapse the specific instance goal sub-tree hiding all descendant goals if the user clicks on the collapse toggle control of that instance goal.

1.3.2.7.2.2 SR.GV-7.2(Non-critical Requirement)

The system shall expand the specific instance goal sub-tree showing all descendant goals whose parent goal has not been collapsed, if the user clicks on the expand toggle control of that instance goal.

1.3.2.7.2.3 SR.GV-7.3(Non-critical Requirement)

The system shall not change the expand/collapse state of any instance goal whose expand/collapse control was not directly clicked.

1.3.3 Assumptions

- There is no need to stack collapsed instance goals under instance goals from the same specification goal. The view space savings from hiding the descendants will shrink the displayed tree sufficiently to allow simultaneous viewing of the desired number of instance goals.
- Java JRE 1.6 or above will be available on platforms using the GMoDS Test Driver or Visualizer.

1.3.4 Constraints

- Applications using GMoDS shall not be forced to include the GMoDS Test Driver or GMoDS Visualizer components in their projects but may optionally do so.

1.3.5 Environment

- Application environment
  - JDK 1.6 or higher available at http://www.sun.com/java.
- Development environment
  - Eclipse IDE for Java Developers 1.2.1.20090918-0703
- GMoDS Version 2
  - The GMoDS component is the GoalModel2 module in the CVS repository cvs.projects.cis.ksu.edu at the repository path /cvsroot/gmods.

2 Chapter 2 Project Plan

2.1 Introduction

This is the final project plan for the GMoDS Visualizer and Test Driver Masters of Software Engineering final project.

2.1.1 Terms

- KSLOC – The size of source code in units of thousands of lines.

2.2 Project Phases

2.2.1 Inception Phase

The inception phase includes tasks to prepare a vision document, project plan, software quality assurance plan, develop an initial prototype, and present the inception phase products to the project supervisory committee.

The prototype will demonstrate a user interface for the GMoDS Visualizer that partially implements the use cases “GV-1 Display Specification Tree”, “GV-2 Display Instance Tree”, and “GV-3 Update Instance Tree”. The UI will also demonstrate the manual mode for the GMoDS Test Driver using a hardwired event script.

The inception phase will conclude upon approval of the supervisory committee.

2.2.2 Elaboration Phase

The elaboration phase includes tasks to revise the vision and project plan documents, develop a formal specification of one aspect of the software, prepare the architectural design document, prepare a test plan, implement an executable architecture prototype, conduct a technical inspection of one elaboration phase artifact, and present elaboration phase products to the supervisory committee.

The executable architecture prototype will demonstrate the architecture of the software on the critical requirements.

The elaboration phase will conclude upon approval of the supervisory committee.

2.2.3 Production Phase

The production phase includes tasks to prepare the component design document, develop the remaining code and tests, conduct testing, evaluate the project, and present production phase products to the supervisory committee.

The production phase presentation will include the production phase artifacts and a final demonstration of the software.

The production phase will end upon approval of the supervisory committee.

2.3 Architecture Elaboration Plan

2.3.1 Revise the Vision Document

The student will incorporate changes suggested by the supervisory committee into the vision document. The revised vision document will be submitted to the major professor for approval.

2.3.2 Revise the Project Plan

The student will revise the project plan to provide a detailed implementation phase plan and revised cost estimate. The revised project plan will be submitted to the major professor for approval.

2.3.3 Develop a Formal Specification

The student will formally specify the visibility and appearance of UI elements corresponding to instance goals in response to GMoDS updates and user interactions using USE and OCL. The formal specification will be submitted to the supervisory committee for approval.

2.3.4 Prepare the Architectural Design Document

The student will prepare an architectural design document to the level of abstraction of component interfaces using appropriate diagrams. The architectural document will undergo technical inspection and be submitted to the supervisory committee for approval.

2.3.5 Prepare the Test Plan

The student will prepare a test plan for the software to be executed in the production phase. The test plan will include unit, integration, and component- and system-level functional tests.

> The plan will include evaluation criteria for all critical use cases and a set of test data deemed adequate for acceptance testing. Specifically, the test plan will identify a set of test cases, the types of tests that will be used for these test cases, the data that will be used for each case, and the requirement traces for each test case [6].

The test plan will be submitted to the supervisory committee for approval.

2.3.6 Conduct a Technical Inspection

The student will prepare an inspection checklist for the architectural design document and coordinate the inspection with the inspectors. Kyle Hill and Shylaja Chippa will serve as inspectors on this project. The inspection check lists and letters will be submitted to the supervisory committee for approval.

2.3.7 Implement an Executable Architecture Prototype

The executable prototype will demonstrate the architecture for the critical requirements established in the GMoDS Test Driver use cases “GTD-1 Issue Scripted Goal Events” and “GTD-2 Issue Random Goal Events” and the GMoDS Visualizer use cases “GV-1 Display Specification Tree”, “GV-2 Display Instance Tree”, and “GV-3 Update Instance Tree”. The demonstration and presentation to the supervisory committee will expose the top technical risks in the project.

2.4 Implementation Plan

2.4.1 Deliverables

The following deliverables will be provided in the production phase per course requirements [6].

2.4.1.1 Action Items

Action items identified during Presentation 2 will be resolved and documented.

2.4.1.2 User Manual

A user manual will be provided. Sections will include an overview and explanations of common usage, user commands, error messages, and data formats.

2.4.1.3 Component Design

The internal design of the components will be documented consistent with their complexity using class, sequence, and state chart diagrams.

2.4.1.4 Source Code

Well documented source code will be submitted consistent with the architectural and component designs.

2.4.1.5 Assessment Evaluation

A test evaluation document will include descriptions of the testing, failures, and reliability estimates. The document will include graphical depiction of software quality metrics.

2.4.1.6 Project Evaluation

A project review document will review both the process and product. The process review will cover methodologies, cost estimation accuracies, and usefulness of technical reviews. The product review will address whether the system requirements have been achieved and evaluate the quality of the product.

2.4.1.7 References

The annotated bibliography will include cited references for all notations used in the portfolio.

2.4.1.8 Formal Technical Inspection Letters

Fellow MSE students Kyle Hill and Shylaja Chippa will provide letters including their formal technical inspection checklist evaluations of this project and stating that the student in question successfully participated in their MSE project as an inspector and that their projects (or at least their formal technical inspection section) have successfully passed the architecture presentation.

2.5 Work Breakdown Structure

Deliverable	Task	Completion Criteria	Time Frame	Time
Source code	Draw relations between non-adjacent specification goals.	Executable code.	9-14 Feb	4 days
	Implement parameter origin value (M) “Modification”.	Executable code.	15-17 Feb	3 days
	Revise event error checking.	Executable code.	18 Feb	0.5 day
	Log event script errors	Executable code.	18 Feb	0.5 day
	Visually notify user of event script errors.	Executable code.	22 Feb	1 day
	Confirm overwrite during save event script.	Executable code.	23 Feb	0.25 day
	Edit random event parameters.	Executable code.	23-24 Feb	2 days
	Edit state parameters	Executable code.	25-28 Feb	2 days
	View specification tree parameters.	Executable code.	1 Mar	0.5 day
	View instance tree parameters	Executable code.	1 Mar	0.25 day
	Expand/collapse instance sub-trees.	Executable code.	2 Mar	1 day
	Show/hide specific instance goal parameters.	Executable code.	3 Mar	1 day
	Show/hide all instances of particular specification goals and their descendants.	Executable code.	4-7 Mar	2 days
Component Design	GMoDS Test Driver Component Design	UML diagrams.	8-9 Mar	1.5 days
	GMoDS Visualizer Component Design	UML diagrams.	9-10 Mar	1.5 days

Deliverable	Task	Completion Criteria	Time Frame	Time
Testing/Assessment Evaluation	Develop Unit Tests	Unit tests complete and passed.	11-17 Mar	5 days
	Develop test case inputs	Inputs complete.	18-22 Mar	3 days
	Run manual test cases and resolve issues.	All test cases complete.	23-30 Mar	6 days
	Evaluate quality metrics.	Quality metric graphs complete.	31 Mar	1 day
	Document test results.	All test case documentation complete.	1-4 Apr	2 days
Action Items	All action item resolutions documented.	All action items resolved and documented.	5 Apr	0.5 day
User Manual	Installation guide	Approved by Major Professor.	5-6 Apr	1.5 day
	User guide	Approved by Major Professor.	6-7 Apr	1.5 day
References	All references documented.	Approved by Major Professor.	8 Apr	0.5 day
Formal Technical Inspection Letters	Send and receive letters from formal inspectors.	Approved by Major Professor.	8 Apr	0.5 day
Project Evaluation	Evaluate process and product.	Approved by Major Professor.	11-13 Apr	3 days
	Compile all project artifacts into an overall portfolio document.	Approved by Major Professor.	14 Apr	1 day

2.6 Cost Estimate

The project is at the end of the Elaboration Phase (phase 2). Table 3 below lists the productivity for source code and documentation development in phases 1 and 2 of this project.

Table 3 Productivity in Phases 1 and 2

Activity Type	Project Time (hours)	Quantity	Productivity
Source Code	85.7	5000 SLOC	58.4 SLOC/Hr
Documentation	68.5	11 Documents	0.16 Doc./Hr
Reading/Research/Misc.	24.5	-	-
	178.7		

I have completed about 51 of 72 (71 %) functional requirements by the end of phase 2.

I estimate that the total SLOC required for the project near 7000 (5000/0.71 = 7059). So approximately 2000 SLOC remain to be written.

I estimate about 36 hours of source code development using the productivity factor of 58.4 SLOC/Hr (2059/58.4 = 35.3 hours). Assuming work of 2 hours/day this translates to approximately 18 days.

I estimate that developing unit tests should take approximately 10 hours (5 days), developing manual test inputs 6 hours (3 days), running manual tests with the GMoDS Test Driver 6 hours (3 days), and running manual tests with a simulation 6 hours (3 days) for a total of 14 days.

There are 5 major documents to produce in the Implementation Phase (component design, assessment evaluation, user manual, project evaluation, and references). I estimate this will take 32 hours (5/0.16 = 31.25) or 16 days. So the total estimated time for phase 3 is 48 days.

2.6.1 Comparison of Cost Estimates

I initially estimated the code size as 3.3 KSLOC using unadjusted function points. The updated code size estimate more than doubles the initial estimate. This discrepancy may be due to inexperience with function point estimation and with the application area.

I initially made an estimate of the most likely the effort and time required using COCOMO 2.0. The most likely time estimate was 7.8 months. The new time estimate places the project conclusion in mid to late April which is well within that time frame.

3 Chapter 3 Software Quality Assurance Plan

3.1 Purpose

This is the initial software quality assurance plan for the GMoDS Visualizer and Test Driver Masters of Software Engineering final project.

3.2 Management

3.2.1 Organization

The GMoDS Visualizer and Test Driver project is organized as follows.

- Developer
  - Mike Fraka
- Major Professor
  - Dr. Scott A. DeLoach
- Supervisory Committee
  - Dr. David Gustafson
  - Dr. Robby
- Technical Inspectors
  - Shylaja Chippa
  - Kyle Hill

3.2.2 Tasks

See Chapter 2 Project Plan for a discussion of all project tasks.

3.2.3 Responsibilities

3.2.3.1 Developer

The developer must produce all artifacts mentioned in 3.3.2 Minimum Documentation Requirements as well as any additional documentation that may be required by the major professor or supervisory committee. The developer must notify the major professor of any technical risks found during conduct of the project.

3.2.3.2 Major Professor

The major professor must monitor the developer's progress and provide guidance as needed. The major professor is considered the primary user for the product.

3.2.3.3 Supervisory Committee

The supervisory committee must review and approve or provide necessary actions to remediate all artifacts presented at the end of each phase of the project.

3.2.3.4 Technical Inspectors

The technical inspectors must inspect the architectural design document using the provided checklist and provide the completed checklist and letter of inspection to the major professor and a copy to the developer.

3.3 Documentation

All project documentation will be available at http://people.cis.ksu.edu/~mfraka/FrakaMSE.html.

3.3.1 Purpose

The purpose of the documentation is to provide a reference to the state of the project and the engineering activities performed by the developer to date.

3.3.2 Minimum Documentation Requirements

Table 4 below shows the minimum documentation required for the GMoDS Visualizer and Test Driver project.

Table 4 GMoDS Visualizer and Test Driver Minimum Documentation

Phase 1	**Phase 2**	**Phase 3**
Time Log	Time Log	Time Log
Vision Document 1.0	Vision Document 2.0	Component Design 1.0
Project Plan 1.0	Project Plan 2.0	Technical Inspection Letters
SQA Plan 1.0	Architectural Design 1.0	Project Evaluation
Initial Executable Prototype	Formal Requirements Specification	Project Source Code
Presentation 1	Technical Inspection Checklist	Executable Project
	Test Plan	User Manual
	Executable Architecture Prototype	Presentation 3
	Presentation 2	

3.4 Standards, practices, conventions, and metrics

The project will follow applicable IEEE standards ([4] [5]) for documents. The source code will use Java naming conventions. The source code will be documented using javadoc. COCOMO 2.0 will be used as the cost estimation metric. Quality will be measured using the rework ratio metric defined as:

$$RW = \frac{E_{Defects}}{E_{Development}}$$

Where $E_{Defeects}$ is the effort spent fixing defects and $E_{Development}$ is the effort spent developing code. Quality also will be measured using the mean time between defects. Both of these metrics can be estimated using the engineering notebook time logs.

3.5 Reviews and audits

The developer will present all artifacts produced in each phase for review and approval by the major professor and supervisory committee.

3.6 Test

The Test Plan will address all testing issues. Please refer to this document when it is produced.

3.7 Problem reporting and corrective action

The major professor may report problems to the developer at any time during the project. The supervisory committee will report problems during each presentation. Any action items will be documented and addressed in the next phase. Action items found at presentation 3 will be addressed before project conclusion.

3.8 Tools, techniques, and methodologies

Table 5 below shows the tools, techniques, and methodologies employed in the GMoDS Visualizer and Test Driver project.

Table 5 GMoDS Visualizer and Test Driver Tools, Techniques, and Methodologies

Tool	Use
Microsoft Word 2007	Prepare all written documents.
Microsoft Excel 2007	Prepare cost estimates.
Microsoft Power Point 2007	Prepare custom figures.
Microsoft Project 2002	Prepare Gantt charts.
XML Spy 2005	Design XML schemas.
Gimp 2.2	Customize images for insertion in documents.
Visual Paradigm for UML 7.0	Prepare UML diagrams and generate source code.
Eclipse IDE for Java Developers 1.2.1.20090918-0703	Develop source code.
JUnit 3.8	Develop and execute unit tests.
USE/OCL	Formally specify UI element behaviors.
Freemind 0.8.1	Record notes and ideas.

3.9 Code control, media control, and supplier control

Project artifacts produced using the Eclipse IDE (mainly source code, configuration files, and tests) will be kept under version control using a Multiagent and Cooperative Robotics (MACR) Laboratory CVS repository and accessed remotely.

Project artifacts produced using other tools (see Table 5 above) will be kept under version control in a local CVS repository on the development machine and backed up at least weekly.

Supplier control is not applicable to this project.

3.10 Records, collection, maintenance, and retention

All project documentation (see 3.3.2 Minimum Documentation Requirements above) will be available at http://people.cis.ksu.edu/~mfraka/FrakaMSE.html when completed. For access to the most current version of GMoDS Visualizer and Test Driver artifacts, contact Dr. Scott DeLoach.

3.11 Risk management

The developer and major professor share responsibility for identifying project risks and communicating them to each other via email or phone.

4 Chapter 4 Architectural Design

4.1 Introduction

4.2 System Architecture

This section documents the system architecture in a component diagram, lists module responsibilities and interface specifications, and describes the design rationale.

4.2.1 System Components

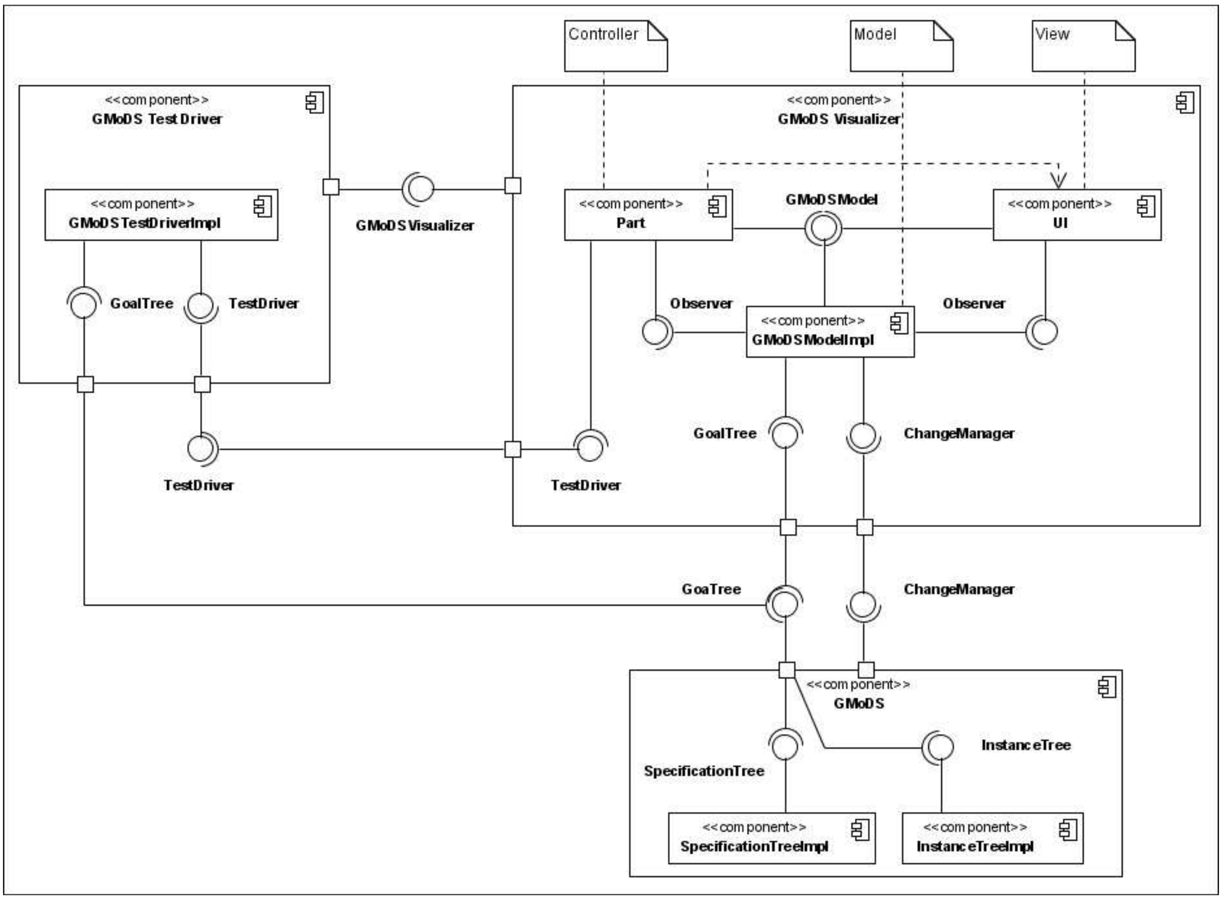


Figure 12 System components

Figure 12 System components shows the three components developed or reused in this project.

The system reuses the Goal Model for Dynamic Systems (GMoDS) component to visualize its behavior. The exact version of GMoDS reused is specified in Chapter 3 Software Quality Assurance Plan. The GMoDS component provides the GoalTree interface and requires the ChangeManager interface. The client uses the GoalTree interface to pull information from GMoDS. GMoDS uses the ChangeManager interface to push information to the client.

The GMoDS Visualizer component provides the user interface for visualizing the behavior of GMoDS. Figure 12 notes show that the GMoDS Visualizer uses the Model-View-Controller

(MVC) architecture. The GMoDS Visualizer defines the TestDriver interface that must be provided by the GMoDS Test Driver when the visualizer is tested using this component. The GMoDS Visualizer provides the GMoDSVisualizer interface to support its initialization.

The GMoDS Test Driver component provides the TestDriver interface implementation to support testing of the GMoDS Visualizer and uses the GMoDSVisualizer interface to initialize it.

4.2.2 System Component Responsibilities

Table 6 System component responsibilities

Component	Responsibilities
GMoDS	Provide the core objects and behaviors to be visualized. Provide pull and push access to these core objects.
GMoDS Visualizer	Provide the user interface for visualizing GMoDS object behaviors. Provide the user interface controls for the GMoDS Test Driver if configured.
GMoDS Test Driver	Provide the capability to test the GMoDS Visualizer in manual and automatic mode.

4.2.3 System Interface Specifications

All interfaces throw an IllegalArgumentException if their preconditions are violated except for the GMoDS Test Driver Launcher main program which prints an error message to the console and exits if its preconditions are not met.

Table 7 GMoDS Test Driver Launcher interface specifications

Launch the GMoDS Test Driver for a specific goal diagram.	Syntax:	main(args : string[]) : void
	Pre:	args.length = 1
	Pre:	args[0] is the goal diagram file name.
	Pre:	args[0] is a file that exists and is readable.
	Post:	The GMoDS component is created, initialized, and passed to the GMoDSTestDriverImpl and GMoDSVisualizerImpl.
	Post:	The GMoDSTestDriverImpl is created and passed to the GMoD Visualizer component.
	Post:	The GMoDSVisualizerImpl is created and initialized. The user interface is created, initialized, and made visible.

Table 8 GMoDSVisualizer interface specifications

Initialize the GMoDS Visualizer resulting in a visible, ready user interface.	Syntax:	initialize() : void
	Pre:	GMoDS GoalTree implementation != null.
	Pre:	GMoDS GoalTree implementation is initialized.
	Post:	The GMoDSVisualizerImpl is initialized. The user interface is created, initialized, and made visible.

Table 9 Test Driver interface specifications

Add an Observer of the event script (as in the Observer design pattern).	Syntax:	addObserver(o : Observer) : void
	Pre:	o != null.
	Post:	An Observer o is recorded and will be notified whenever the state of the EventScript changes.

Load an event script XML file into the TestDriver.	Syntax:	loadEventScript(eventScript : File) : void
	Pre:	eventScript != null.
	Pre:	eventScript File exists, is a File, and can be read.
	Post:	An EventScriptImpl is created from the eventScript File.
	Post:	All valid GoalEvents specified in eventScript are included in the EventScriptImpl
	Post:	The TestDriver enters manual mode.
	Post:	All invalid GoalEvents are discarded and the user is notified visually and in a log file of discarded GoalEvents.
Save the current event script as an XML file.	Syntax:	saveEventScript(eventScript : File) : void
	Pre:	TestDriver is in manual mode.
	Pre:	eventScript != null.
	Pre:	User must have permission to write the eventScript File.
	Pre:	If eventScript File exists then user must confirm that it will be overwritten.
	Post:	The current EventScript of validated Goal Events (events that have already been confirmed to refer to instance goals that exist in GMoDS) will be written to eventScript File using the XML schema defined in Chapter 1 Vision Document.
	Post:	The TestDriver remains in manual mode.
Begin issuing random events using the current random event configuration parameters.	Syntax:	issueRandomEvents() : void
	Pre:	None.
	Post:	A RandomEventScriptImpl is created using the RandomEventParameters in effect during the method call.
	Post:	The TestDriver enters manual mode.

Place the TestDriver in automatic mode.	Syntax:	play() : void
	Pre:	TestDriver is in manual mode.
	Pre:	TestDriver has a next GoalEvent it can issue.
	Post:	The TestDriver enters automatic mode.
Place the TestDriver in manual mode.	Syntax:	pause() : void
	Pre:	TestDriver is in automatic mode.
	Pre:	TestDriver has a next GoalEvent it can issue.
	Post:	The TestDriver enters manual mode.
Issue the next event to GMoDS.	Syntax:	next() : void
	Pre:	TestDriver is in manual mode.
	Pre:	TestDriver has a next GoalEvent it can issue.
	Pre:	The next GoalEvent refers to a valid instance goal.
	Post:	The TestDriver issues the next GoalEvent to GMoDS.
	Post:	The TestDriver remains manual mode.
Determine if the TestDriver has a next event to issue to GMoDS.	Syntax:	hasNext() : boolean
	Pre:	None.
	Post:	Result = TestDriver has a next valid GoalEvent that can be issued to GMoDS.

4.2.4 System Architecture Design Rationale

The system architecture uses the Model-View-Controller (MVC) design pattern. The GMoDS Visualizer component has both the view and controller roles. The GMoDS Test Driver (if applicable) and the GMoDS components are both assigned the model role. The GMoDS Test Driver encapsulates the core GoalEvent objects that it can issue to GMoDS behind a well-defined TestDriver interface. This interface also implements the Observer design pattern to support the notification of the GMoDS Visualizer that it should check whether valid GoalEvents remain to be issued. The GMoDS component is encapsulated behind a GMoDSModel interface within the GMoDS Visualizer component allowing custom methods to support GMoDS Visualizer requirements.

4.3 GMoDS Test Driver Architecture

4.3.1 GMoDS Test Driver Decomposition

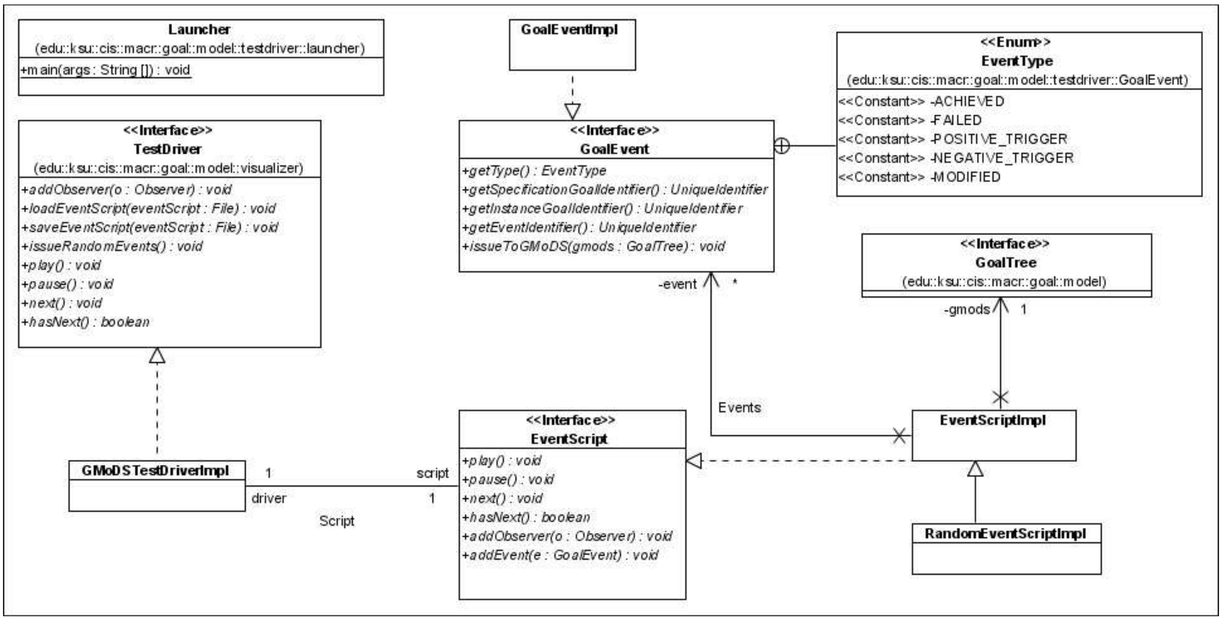

Launcher
(edu::ksu::cis::macr::goal::model::testdriver::launcher)
+main(args : String []) : void
GoalEventImpl
<<Enum>>
EventType
(edu::ksu::cis::macr::goal::model::testdriver::GoalEvent)
<<Constant>> -ACHIEVED
<<Constant>> -FAILED
<<Constant>> -POSITIVE_TRIGGER
<<Constant>> -NEGATIVE_TRIGGER
<<Constant>> -MODIFIED
<<Interface>>
TestDriver
(edu::ksu::cis::macr::goal::model::visualizer)
+addObserver(o : Observer) : void
+loadEventScript(eventScript : File) : void
+saveEventScript(eventScript : File) : void
+issueRandomEvents() : void
+play() : void
+pause() : void
+next() : void
+hasNext() : boolean
<<Interface>>
GoalEvent
+getType() : EventType
+getSpecificationGoalIdentifier() : UniqueIdentifier
+getInstanceGoalIdentifier() : UniqueIdentifier
+getEventIdentifier() : UniqueIdentifier
+issueToGMoDS(gmods : GoalTree) : void
<<Interface>>
GoalTree
(edu::ksu::cis::macr::goal::model)
-event
*
-gmods
1
Events
GMoDSTestDriverImpl
1
driver
script
1
Script
<<Interface>>
EventScript
+play() : void
+pause() : void
+next() : void
+hasNext() : boolean
+addObserver(o : Observer) : void
+addEvent(e : GoalEvent) : void
EventScriptImpl
RandomEventScriptImpl

Figure 13 GMoDS Test Driver architectural modules

Figure 13 above shows the GMoDS Test Driver component architecture. Since this is a small component and since it is used in the formal specification all GMoDS Test Driver modules are shown in the diagram.

4.3.2 GMoDS Test Driver Module Responsibilities

Table 10 GMoDS Test Driver module responsibilities

Component	Responsibilities
Launcher	Configure GMoDS, GMoDSTestDriverImpl, and the GMoDSVisualizerImpl. Initialize GMoDS and the GMoDSVisualizerImpl.
GMoDTestDriverImpl	Hold an EventScript. Implement loadEventScript and issueRandomEvents to create and install EventScriptImpl and RandomEventScriptImpl, respectively.
EventScript	Define the behaviors of any EventScript.
EventScriptImpl	Hold the list of GoalEvents defining the script and provide default implementations of the EventScript interface.

Component	Responsibilities
RandomEventScriptImpl	Override the EventScriptImpl to create and issue random GoalEvents based on the RandomEventParameters configured by the user and the events defined by the goal diagram.
GoalEvent	Define the behaviors of a GoalEvent.
EventType	Define the possible types of any event in a goal diagram.
GoalEventImpl	Implement the GoalEvent interface.

4.3.3 GMoDS Test Driver Interface Specifications

Table 11 GMoDS Test Driver GoalEvent interface specifications

Access the EventType of a GoalEvent.	Syntax:	getType() : EventType
	Pre:	None.
	Post:	Result = this.eventType
Access the UniqueIdentifier of the specification goal referenced by a GoalEvent.	Syntax:	getSpecificationGoalIdentifier() : UniqueIdentifier
	Pre:	None.
	Post:	Result = this.specificationGoalID
Access the UniquieIdentifier of the instance goal referenced by a GoalEvent.	Syntax:	getInstanceGoalIdentifier() : UniqueIdentifier
	Pre:	None.
	Post:	Result = this.instanceGoalID
Access the UniqueIdentifier of the SpecificationEvent referenced by a GoalEvent.	Syntax:	getEventGoalIdentifier() : UniqueIdentifier
	Pre:	this.eventType = EventType.POSITIVE_TRIGGER or this.eventType = EventType.NEGATIVE_TRIGGER
	Post:	Result = this.eventID

Table 12 GMoDS Test Driver EventScript interface specifications

Add an event valid with respect to the GMoDS specification tree to the end of the script.	Syntax:	addEvent(e : GoalEvent) : void
	Pre:	e != null
	Pre:	e is not already included in the script.
	Pre:	e.type is valid.
	Pre:	if e.type = #MODIFIED then at least one parameter must be provided for the event.
	Pre:	e.getSpecificationGoalIdentifier() refers to a specification goal that exists in the specification tree.
	Pre:	if e.type = #ACHIEVED then e.getSpecificationGoalIdentifier() = 'ACHIEVED' and the specification goal is a leaf.
	Pre:	if e.type = #FAILED then e.getSpecificationGoalIdentifier() = 'FAILED' and the specification goal is a leaf.
	Pre:	if e.type != #MODIFIED then e.getSpecificationEventIdentiifer() refers to an specification event defined in the specification tree.
	Post:	(events – events@pre)->size() = 1
	Post:	events.includes(e)
	Post:	events.last() = e
Place the EventScript in automatic mode.	Syntax:	play() : void
	Pre:	EventScript is in manual mode.
	Pre:	EventScript has a next GoalEvent it can issue.
	Post:	The EventScript enters automatic mode.

Place the EventScript in manual mode.	Syntax:	pause() : void
	Pre:	EventScript is in automatic mode.
	Pre:	EventScript has a next GoalEvent it can issue.
	Post:	The EventScript enters manual mode.
Issue the next event to GMoDS.	Syntax:	next() : void
	Pre:	EventScript is in manual mode.
	Pre:	EventScript has at least 1 event.
	Pre:	EventScript has a next GoalEvent it can issue.
	Pre:	The next GoalEvent refers to a valid instance goal.
	Pre:	If next GoalEvent type != #MODIFIED then the next event refers to a valid active instance goal.
	Post:	If the next GoalEvent type != #MODIFIED the EventScript issues the next GoalEvent to the GMoDS event method.
	Post:	If the next GoalEvent type = #MODIFIED the EventScript issues the next GoalEvent to the GMoDS modifyInstanceGoal method.
	Post:	The EventScript index refers to the next event if one exists.
	Post:	The EventScript remains manual mode.
Determine if the EventScript has a next event to issue to GMoDS.	Syntax:	hasNext() : boolean
	Pre:	None.
	Post:	Result = EventScript has a next valid GoalEvent that can be issued to GMoDS.
Add an Observer of the event script (as in the Observer design pattern).	Syntax:	addObserver(o : Observer) : void
	Pre:	o != null.
	Post:	An Observer o is recorded and will be notified whenever the state of the EventScript changes.

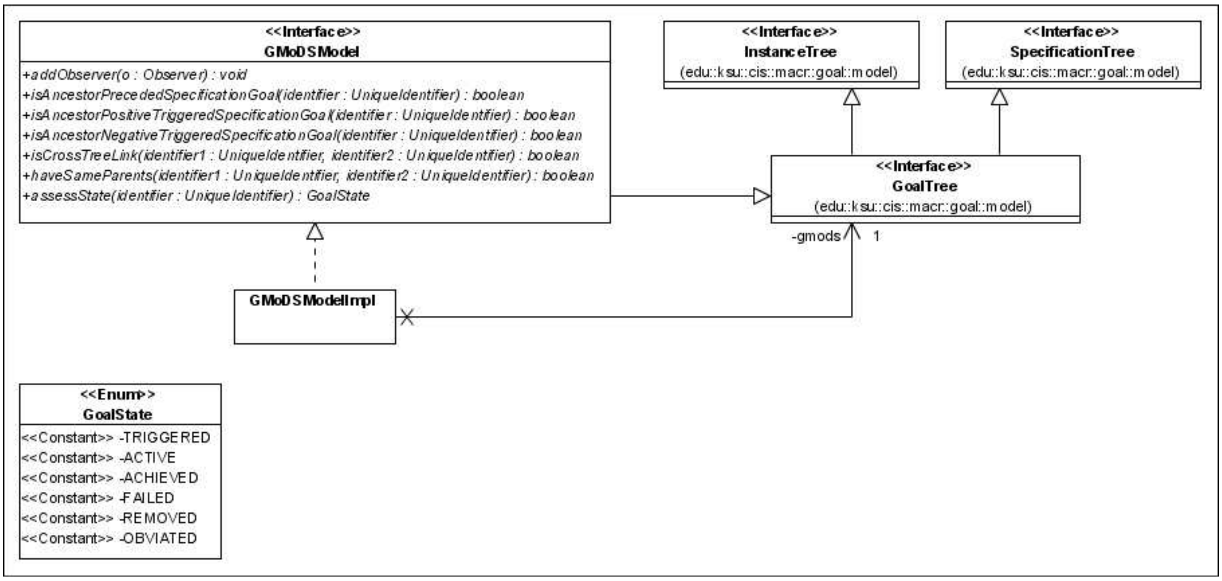
4.3.4 GMoDS Test Driver Design Rationale

The heart of the GMoDS Test Driver is the EventScriptImpl and RandomEventScriptImpl that extends it and the GoalEventImpl. The EventScriptImpl provides the deterministic (usually file-based) event script functionality. The RandomEventScriptImpl provides random GoalEvent generation. The GoalEventImpl enforces the invariants that assure valid InstanceGoals and SpecificationEvents are sent to GMoDS. The GMoDS Test Driver architecture was derived from analysis of the objects referenced in Chapter 1 Vision Document.

4.4 GMoDS Visualizer Architecture

The GMoDS Visualizer uses the MVC architectural design pattern. Each section that follows decomposes the modules that take on each role in the MVC design pattern. I did not make use of the Command design pattern because the visualizer has no requirement to support undo operations.

4.4.1 GMoDS Visualizer Model Decomposition



<<Interface>>
GMoDSModel
+addObserver(o : Observer) : void
+isAncestorPrecededSpecificationGoal(identifier : UniqueIdentifier) : boolean
+isAncestorPositiveTriggeredSpecificationGoal(identifier : UniqueIdentifier) : boolean
+isAncestorNegativeTriggeredSpecificationGoal(identifier : UniqueIdentifier) : boolean
+isCrossTreeLink(identifier1 : UniqueIdentifier, identifier2 : UniqueIdentifier) : boolean
+haveSameParents(identifier1 : UniqueIdentifier, identifier2 : UniqueIdentifier) : boolean
+assessState(identifier : UniqueIdentifier) : GoalState
<<Interface>>
InstanceTree
(edu::ksu::cis::macr::goal::model)
<<Interface>>
SpecificationTree
(edu::ksu::cis::macr::goal::model)
<<Interface>>
GoalTree
(edu::ksu::cis::macr::goal::model)
-gmods
1
GMoDSModelImpl
<<Enum>>
GoalState
<<Constant>> -TRIGGERED
<<Constant>> -ACTIVE
<<Constant>> -ACHIEVED
<<Constant>> -FAILED
<<Constant>> -REMOVED
<<Constant>> -OBVIATED

Figure 14 GMoDS Visualizer model modules

4.4.2 GMoDS Visualizer Model Module Responsibilities

Table 13 GMoDS Visualizer model module responsibilities

Component	Responsibilities
GoalState	Enumeration of possible goal states.
GMoDSModel	Define methods for access and evaluation of the core GMoDS objects.
GMoDSModelImpl	Implement methods for access and evaluation of the core GMoDS objects.

4.4.3 GMoDS Visualizer Model Interface Specifications

Table 14 below shows custom methods for accessing and evaluating core GMoDS objects. The methods defined for GMoDS native interfaces (GoalTree, SpecificationTree, and InstanceTree) are not documented in this paper.

Table 14 GMoDS Visualizer GMoDSModel interface specifications

Add an Observer of the GMoDSModel (as in the Observer design pattern).	Syntax:	addObserver(o : Observer) : void
	Pre:	o != null.
	Post:	An Observer o is recorded and will be notified whenever the state of GMoDS changes.
Determine if any ancestor of the specified specification goal is the target of a precedes relation.	Syntax:	isAncestorPrecededSpecificationGoal(identifier : UniqueIdentifier) : boolean
	Pre:	identifier != null.
	Post:	Result = true if any ancestor of the specified specification goal is the target of a precedes relation.
Determine if any ancestor of the specified specification goal is the target of a positive trigger.	Syntax:	isAncestorPositiveTriggeredSpecificationGoal (identifier : UniqueIdentifier) : boolean
	Pre:	identifier != null.
	Post:	Result = true if any ancestor of the specified specification goal is the target of a positive trigger.
Determine if any ancestor of the specified specification goal is the target of a negative trigger.	Syntax:	isAncestorNegativeTriggeredSpecificationGoal (identifier : UniqueIdentifier) : boolean
	Pre:	identifier != null.
	Post:	Result = true if any ancestor of the specified specification goal is the target of a negative trigger.

Determine if the two specified specification goals do not have the same parents.	Syntax:	isCrossTreeLink (identifier1 : UniqueIdentifier, identifier2 : UniqueIdentifier) : boolean
	Pre:	identifier1 != null.
	Pre:	identifier2 != null.
	Post:	Result = true if the two specified specification goals do not have the same parents.
Determine if the two specified specification goals have the same parents.	Syntax:	haveSameParents (identifier1 : UniqueIdentifier, identifier2 : UniqueIdentifier) : boolean
	Pre:	identifier1 != null.
	Pre:	identifier2 != null.
	Post:	Result = true if the two specified specification goals have the same parents.
Evaluate the GoalState of the specified instance goal.	Syntax:	assessState(identifier : UniqueIdentifier) : GoalState
	Pre:	identifier != null.
	Post:	Result = the GoalState of the specified instance goal.

4.4.4 GMoDS Visualizer Model Design Rationale

The GMoDS component is encapsulated behind a GMoDSModel interface within the GMoDS Visualizer component to allow custom methods to support GMoDS Visualizer requirements.

4.4.5 GMoDS Visualizer View Decomposition

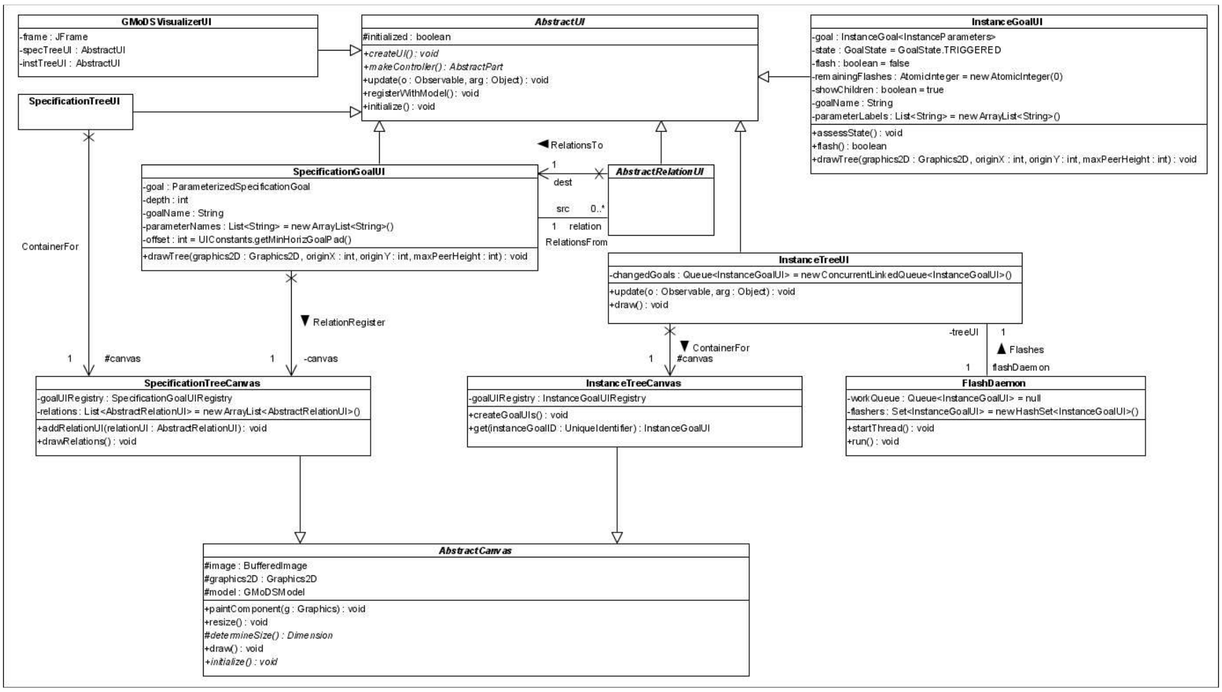

GMoDSVisualizerUI
-frame : JFrame
-specTreeUI : AbstractUI
-instTreeUI : AbstractUI
SpecificationTreeUI
AbstractUI
#initialized : boolean
+createUI() : void
+makeController() : AbstractPart
+update(o : Observable, arg : Object) : void
+registerWithModel() : void
+initialize() : void
InstanceGoalUI
-goal : InstanceGoal<InstanceParameters>
-state : GoalState = GoalState.TRIGGERED
-flash : boolean = false
-remainingFlashes : AtomicInteger = new AtomicInteger(0)
-showChildren : boolean = true
-goalName : String
-parameterLabels : List<String> = new ArrayList<String>()
+assessState() : void
+flash() : boolean
+drawTree(graphics2D : Graphics2D, originX : int, originY : int, maxPeerHeight : int) : void
RelationsTo
1
dest
src
0..*
1
relation
RelationsFrom
SpecificationGoalUI
-goal : ParameterizedSpecificationGoal
-depth : int
-goalName : String
-parameterNames : List<String> = new ArrayList<String>()
-offset : int = UIConstants.getMinHorizGoalPad()
+drawTree(graphics2D : Graphics2D, originX : int, originY : int, maxPeerHeight : int) : void
AbstractRelationUI
ContainerFor
InstanceTreeUI
-changedGoals : Queue<InstanceGoalUI> = new ConcurrentLinkedQueue<InstanceGoalUI>()
+update(o : Observable, arg : Object) : void
+draw() : void
RelationRegister
1
#canvas
1
-canvas
ContainerFor
1
#canvas
-treeUI
1
Flashes
1
flashDaemon
SpecificationTreeCanvas
-goalUIRegistry : SpecificationGoalUIRegistry
-relations : List<AbstractRelationUI> = new ArrayList<AbstractRelationUI>()
+addRelationUI(relationUI : AbstractRelationUI) : void
+drawRelations() : void
InstanceTreeCanvas
-goalUIRegistry : InstanceGoalUIRegistry
+createGoalUIs() : void
+get(instanceGoalID : UniqueIdentifier) : InstanceGoalUI
FlashDaemon
-workQueue : Queue<InstanceGoalUI> = null
-flashers : Set<InstanceGoalUI> = new HashSet<InstanceGoalUI>()
+startThread() : void
+run() : void
AbstractCanvas
#image : BufferedImage
#graphics2D : Graphics2D
#model : GMoDSModel
+paintComponent(g : Graphics) : void
+resize() : void
#determineSize() : Dimension
+draw() : void
+initialize() : void

Figure 15 GMoDS Visualizer view modules

4.4.6 GMoDS Visualizer View Module Responsibilities

Table 15 GMoDS Visualizer view module responsibilities

Component	Responsibilities
AbstractUI	Define the basic behaviors and responsibilities of the view role. Hold references to the core model and TestDriver if present.
AbstractCanvas	Hold the Java 2D image upon which a diagram is drawn. Define the methods concrete canvases must support.
GMoDSVisualizerUI	The top level concrete user interface. Hold the JFrame containing all visual components. Provide the JMenuBar and host the TestDriver JToolBar. Hold the SpecificationTreeUI and InstanceTreeUI in a JSplitPane.
SpecificationTreeUI	Define the UI for the specification tree. Provide zoom and scroll controls for the specification tree.
SpecificationTreeCanvas	Draw the specification tree.
SpecificationGoalUI	Define the UI for a specification goal.

Component	Responsibilities
AbstractRelationUI	Define the basic behaviors of a relation UI between 2 specification goal UIs. Used for positive and negative triggers and precedes relations.
InstanceTreeUI	Define the UI for the instance tree. Provide zoom and scroll controls for the instance tree.
InstanceTreeCanvas	Draw the instance tree.
InstanceGoalUI	Define the UI for an instance goal.
FlashDaemon	Flash added and changed instance goal UIs for the desired rate and duration.

4.4.7 GMoDS Visualizer View Interface Specifications

Table 16 GMoDS Visualizer AbstractUI interface specifications

Create this view and all subordinate views.	Syntax:	createUI() : void
	Pre:	None.
	Post:	This view and all subordinate views are created.
Create the appropriate controller for this view.	Syntax:	makeController() : AbstractPart
	Pre:	None.
	Post:	Result = The appropriate controller for this view is created.
Respond to notification of a change in the model.	Syntax:	update (o : Observable, arg : Object) : void
	Pre:	The Observable o (the model) has changed state.
	Post:	This view makes appropriate changes to the view based on changes in the Observable.
Register with the model if this view needs to do so.	Syntax:	registerWithModel() : void
	Pre:	None.
	Post:	If this view needs to receive updates from the model it registers as an Observer with it.

Initialize this view.	Syntax:	initialize() : void
	Pre:	None.
	Post:	This view and all subordinate views are initialized.

Table 17 GMoDS Visualizer AbstractCanvas interface specifications

Paint the component holding the Java 2D image.	Syntax:	paintComponent(g : Graphics) : void
	Pre:	None.
	Post:	This canvas paints the component it holds that displays the image with the Java 2D drawing.
Create an image with a white background using the dimensions that will contain all drawing elements.	Syntax:	resize() : void
	Pre:	None.
	Post:	This canvas calculates the minimum dimensions for its displayed image, resizes it, and fills it with a white background.
Determine the minimum dimensions that will contain all drawing elements.	Syntax:	determineSize() : void
	Pre:	None.
	Post:	The concrete canvas should calculate the minimum dimensions for its displayed elements.
Draw viewed elements on the Java 2D image.	Syntax:	draw() : void
	Pre:	None.
	Post:	The concrete canvas draws its elements on the Java 2D image.
Initialize the canvas.	Syntax:	initialize() : void
	Pre:	None.
	Post:	The canvas is initialized.

Table 18 GMoDS Visualizer SpecificationTreeCanvas interface specifications

Add an AbstractRelationUI to the list of relations to draw.	Syntax:	addRelationUI(relationUI : AbstractRelationUI) : void
	Pre:	None.
	Post:	The relationUI is added to the list of relationUIs drawn on the canvas.
Draw the AbstractRelationUIs on the image.	Syntax:	drawRelations() : void
	Pre:	None.
	Post:	All AbstractRelationUIs are drawn on the canvas.

Table 19 GMoDS Visualizer SpecificationGoalUI interface specifications

Draw the SpecificationGoalUI and its descendants on the image.	Syntax:	drawTree(graphics2D : Graphics2D) : void
	Pre:	None.
	Post:	This SpecificationGoalUI and its descendants are drawn on the Java 2D image.

Table 20 GMoDS Visualizer InstanceTreeUI interface specifications

Begin flashing added or changed InstanceGoalUIs.	Syntax:	update (o : Observable, arg : Object) : void
	Pre:	The Observable o (the model) has changed state.
	Post:	Added or changed InstanceGoalUIs begin to flash.
Draw and repaint the canvas.	Syntax:	draw() : void
	Pre:	None.
	Post:	The canvas held by this view is redrawn and repainted to allow dynamic changes to appear.

Table 21 GMoDS Visualizer InstanceTreeCanvas interface specifications

Create all added InstanceGoalUIs.	Syntax:	createGoalUIs() : void
	Pre:	None.
	Post:	This canvas creates all added InstanceGoalUIs and assures they are ordered, assessed, and registered for later display.
Get the specified InstanceGoalUI.	Syntax:	get(instanceGoalID : UniqueIdentifier) : InstanceGoalUI
	Pre:	None.
	Post:	Result = the InstanceGoalUI specified by the instanceGoalID.

Table 22 GMoDS Visualizer InstanceGoalUI interface specifications

Assess and record the GoalState of this InstanceGoalUI.	Syntax:	assessState() : void
	Pre:	None.
	Post:	this.state = model.assessState(goal.getIdentifier())
Invert the flash property, calculate the remaining number of flashes, and return false when there are no remaining flashes.	Syntax:	flash() : boolean
	Pre:	None.
	Post:	flash = !flash
	Post:	if (!flash) remainingFlashes = remainingFlashes@pre – 1
	Post:	Result = remainingFlashes > 0
Draw this InstanceGoalUI and its descendants on the image.	Syntax:	drawTree(graphics2D : Graphics2D) : void
	Pre:	None.
	Post:	This InstanceGoalUI and its descendants are drawn on the Java 2D image.

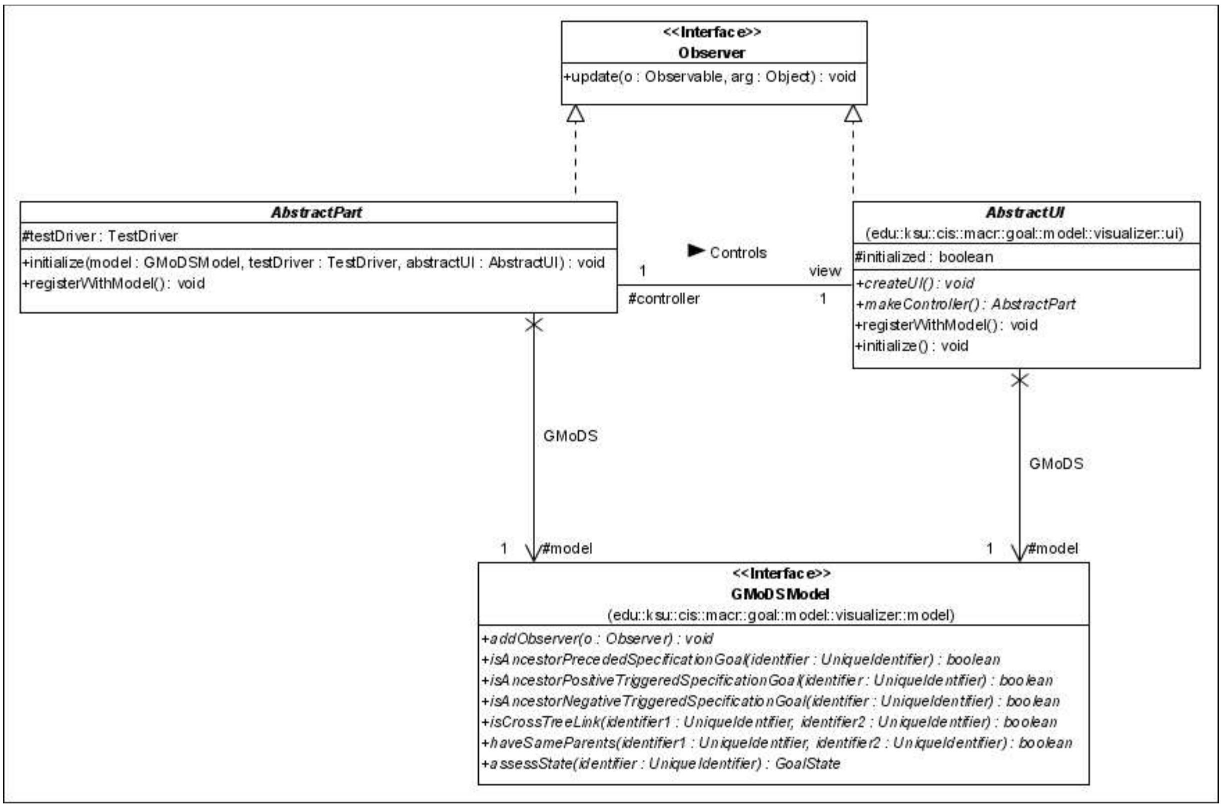
Table 23 GMoDS Visualizer FlashDaemon interface specifications

Start the Thread executing the run() method of the FlashDaemon.	Syntax:	startThread() : void
	Pre:	The thread is not running.
	Post:	The thread calling FlashDaemon.run() is started.
The asynchronous process that signals added/changed InstanceGoalUIs to invert their flash property and redraws the instance tree.	Syntax:	run() : void
	Pre:	The thread is running.
	Body:	The FlashDaemon polls for and adds all InstanceGoalUIs in its workQueue to the set of flashing goals (flashers).
	Body:	If there are no flashers, wait until notified that a flasher has been added.
	Body:	If there are flashers, flash each flasher and redraw the InstanceTreeUI.
	Body:	Remove all flashers whose flash() method returns false.
	Post:	None. The thread never exits until the system exits.

4.4.8 GMoDS Visualizer View Design Rationale

I selected the MVC design pattern to allow for maximum flexibility in designing views of the core GMoDS objects.

4.4.9 GMoDS Visualizer Controller Decomposition



<<Interface>>
Observer
+update(o : Observable, arg : Object) : void
AbstractPart
#testDriver : TestDriver
+initialize(model : GMoDSModel, testDriver : TestDriver, abstractUI : AbstractUI) : void
+registerWithModel() : void
Controls
1
view
#controller
1
AbstractUI
(edu::ksu::cis::macr::goal::model::visualizer::ui)
#initialized : boolean
+createUI() : void
+makeController() : AbstractPart
+registerWithModel() : void
+initialize() : void
GMoDS
GMoDS
1
#model
1
#model
<<Interface>>
GMoDSModel
(edu::ksu::cis::macr::goal::model::visualizer::model)
+addObserver(o : Observer) : void
+isAncestorPrecededSpecificationGoal(identifier : UniqueIdentifier) : boolean
+isAncestorPositiveTriggeredSpecificationGoal(identifier : UniqueIdentifier) : boolean
+isAncestorNegativeTriggeredSpecificationGoal(identifier : UniqueIdentifier) : boolean
+isCrossTreeLink(identifier1 : UniqueIdentifier, identifier2 : UniqueIdentifier) : boolean
+haveSameParents(identifier1 : UniqueIdentifier, identifier2 : UniqueIdentifier) : boolean
+assessState(identifier : UniqueIdentifier) : GoalState

Figure 16 GMoDS Visualizer controller modules

4.4.10 GMoDS Visualizer Controller Module Responsibilities

Table 24 GMoDS Visualizer controller module responsibilities

Component	Responsibilities
AbstractPart	Define basic methods for setting up a controller associated with its view, model, and TestDriver.

4.4.11 GMoDS Visualizer Controller Interface Specifications

Table 25 GMoDS Visualizer AbstractPart interface specifications

AbstractPart intialize	Syntax:	initialize(model : GMoDSModel, testDriver : TestDriver, abstractUI : AbstractUI) : void
	Pre:	None.
	Post:	This controller is initialized with references to the model, view, and TestDriver.

AbstractPart registerWithModel	Syntax:	registerWithModel() : void
	Pre:	None.
	Post:	If this controller needs to receive updates from the model it registers as an Observer with it or the TestDriver.

4.4.12 GMoDS Visualizer Controller Design Rationale

I selected the MVC design pattern to support unit testing of controller behaviors.

4.5 System Startup Behavior

Figure 17 through Figure 23 illustrate the system startup behavior. Figure 17 shows the steps taken by the GMoDS Test Driver Launcher main program to make use of the GMoDS Visualizer. Simulation components should follow these same steps except that they will skip creating a TestDriver and pass null into the constructor of GMoDSVisualizerImpl for the TestDriver parameter. The figures also illustrate the initialization of the MVC architecture.

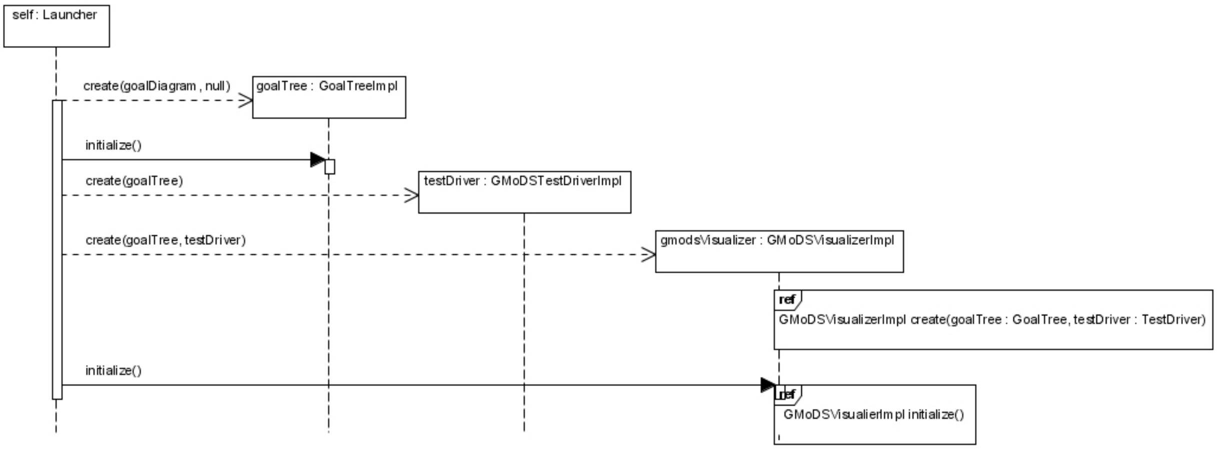

self : Launcher
create(goalDiagram , null)
goalTree : GoalTreeImpl
initialize()
create(goalTree)
testDriver : GMoDSTestDriverImpl
create(goalTree, testDriver)
gmodsVisualizer : GMoDSVisualizerImpl
ref
GMoDSVisualizerImpl create(goalTree : GoalTree, testDriver : TestDriver)
initialize()
ref
GMoDSVisualierImpl initialize()

Figure 17 GMoDS Test Driver Launcher main program behavior

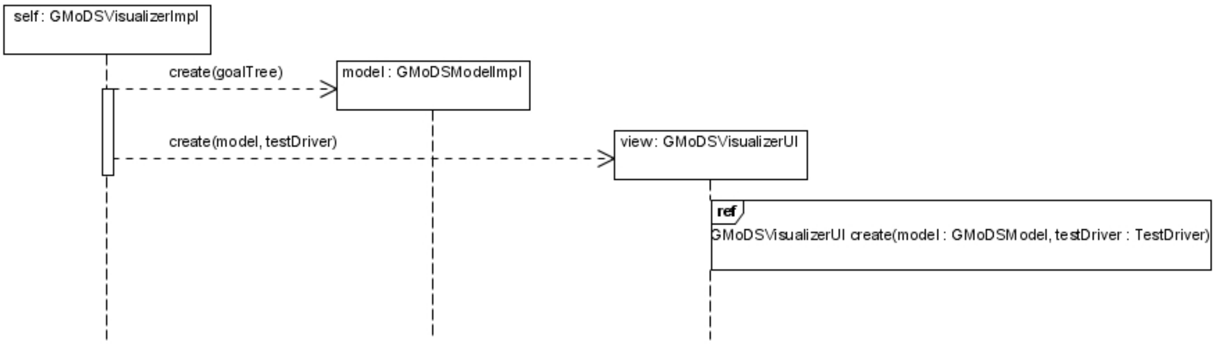

self : GMoDSVisualizerImpl
create(goalTree)
model : GMoDSModelImpl
create(model, testDriver)
view: GMoDSVisualizerUI
ref
GMoDSVisualizerUI create(model : GMoDSModel, testDriver : TestDriver)

Figure 18 GMoDSVisualizerImpl create(goalTree : GoalTree, testDriver : TestDriver)

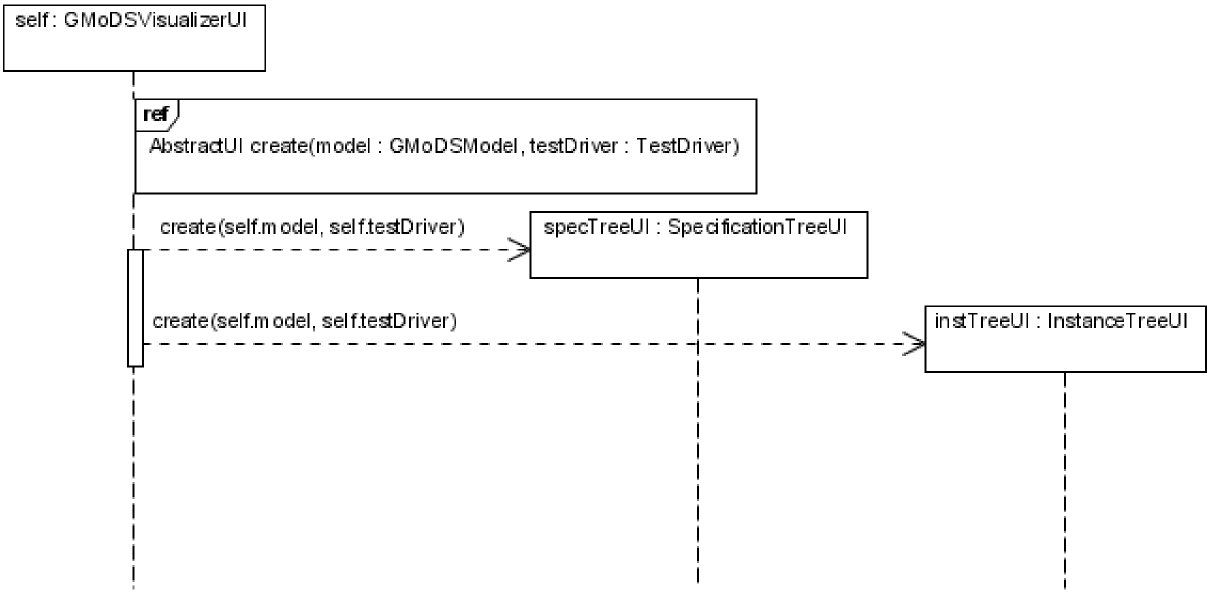

self : GMoDSVisualizerUI
ref
AbstractUI create(model : GMoDSModel, testDriver : TestDriver)
create(self.model, self.testDriver)
specTreeUI : SpecificationTreeUI
create(self.model, self.testDriver)
instTreeUI : InstanceTreeUI

Figure 19 GMoDSVisualizerUI create(model : GMoDSModel, testDriver : TestDriver)

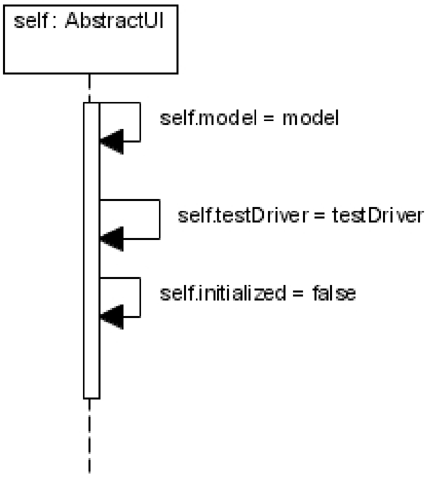


Figure 20 AbstractUI create(model : GMoDSModel, testDriver : TestDriver)

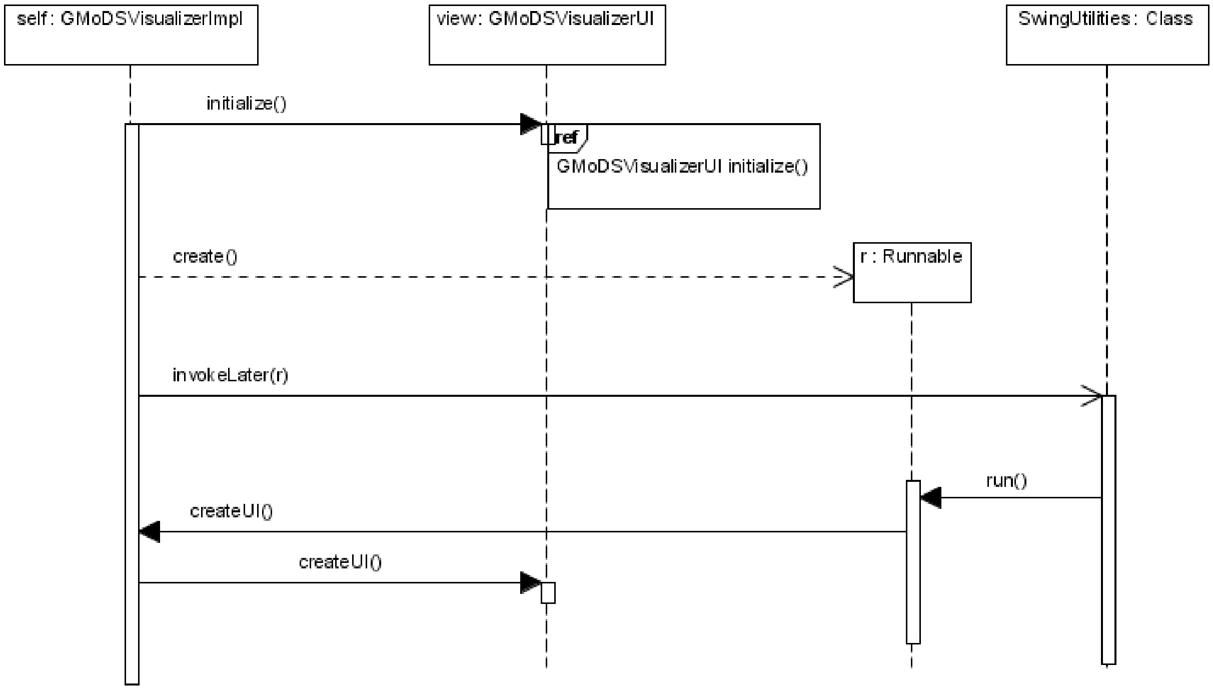


Figure 21 GMoDSVisualizerImpl initialize()

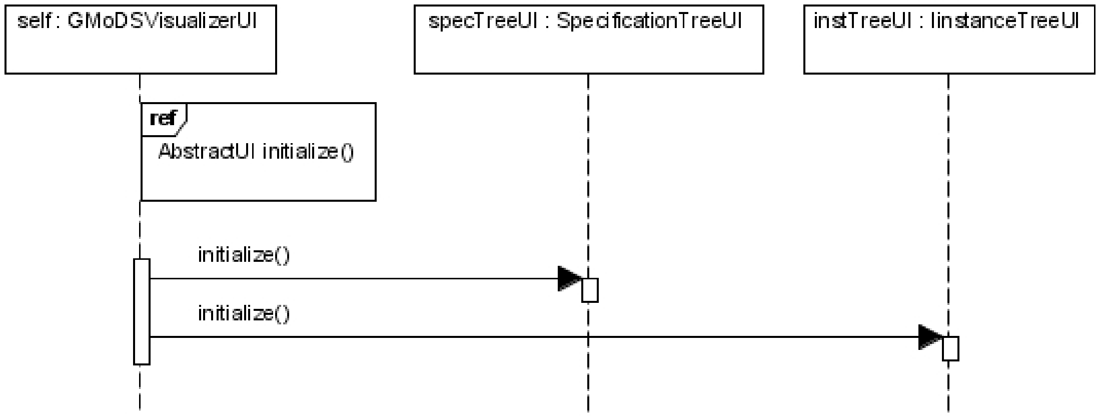


Figure 22 GMoDSVisualizerUI initialize()

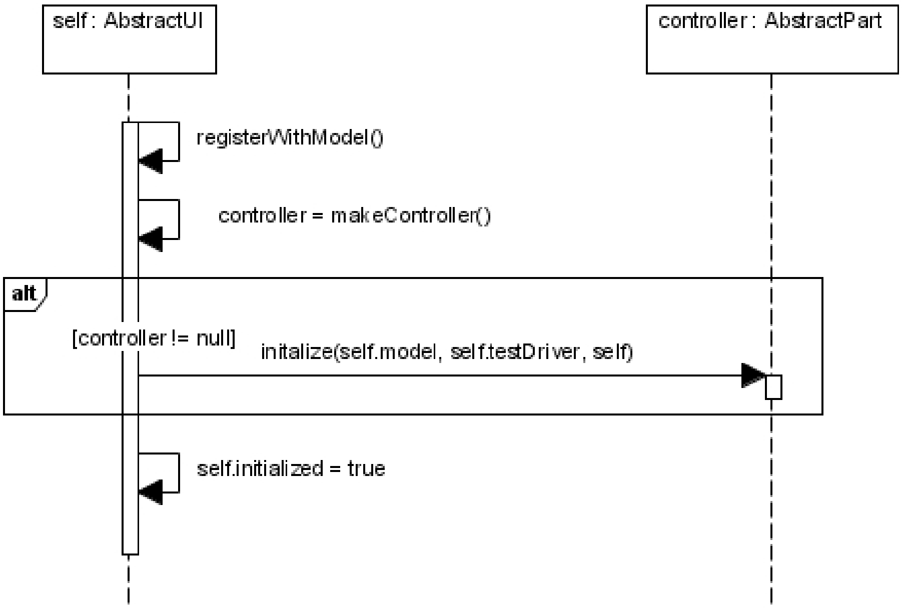

self : AbstractUI
controller : AbstractPart
registerWithModel()
controller = makeController()
alt
[controller != null]
initalize(self.model, self.testDriver, self)
self.initialized = true

Figure 23 AbstractUI initialize()

4.6 GMoDS Architecture

Figure 24 below documents selected GMoDS and GMoDS Test Driver classes for the sole purpose of supporting USE/OCL modeling of invariants on EventScriptImpl (a GMoDS Test Driver class). This diagram should not be taken for official GMoDS documentation. The diagram is an abstraction of the real architecture designed to make it easier to perform USE/OCL modeling. In particular, I replaced use of UniqueIdentifier with the equivalent primitive data types used for specification and instance goal identifiers. Also, GoalEventParameter, SpecificationParameter, and InstanceParameter were created to replace the use of Map data structures mapping from a parameter UniqueIdentifier to an arbitrary value Object. I omitted the SpecificationParameters class since it was not needed in any OCL invariants. Finally, the signature of "modifyInstanceGoal" was altered to include separate specification and instance goal IDs where the real signature uses a UniqueIdentifier that encapsulates both of these IDs.

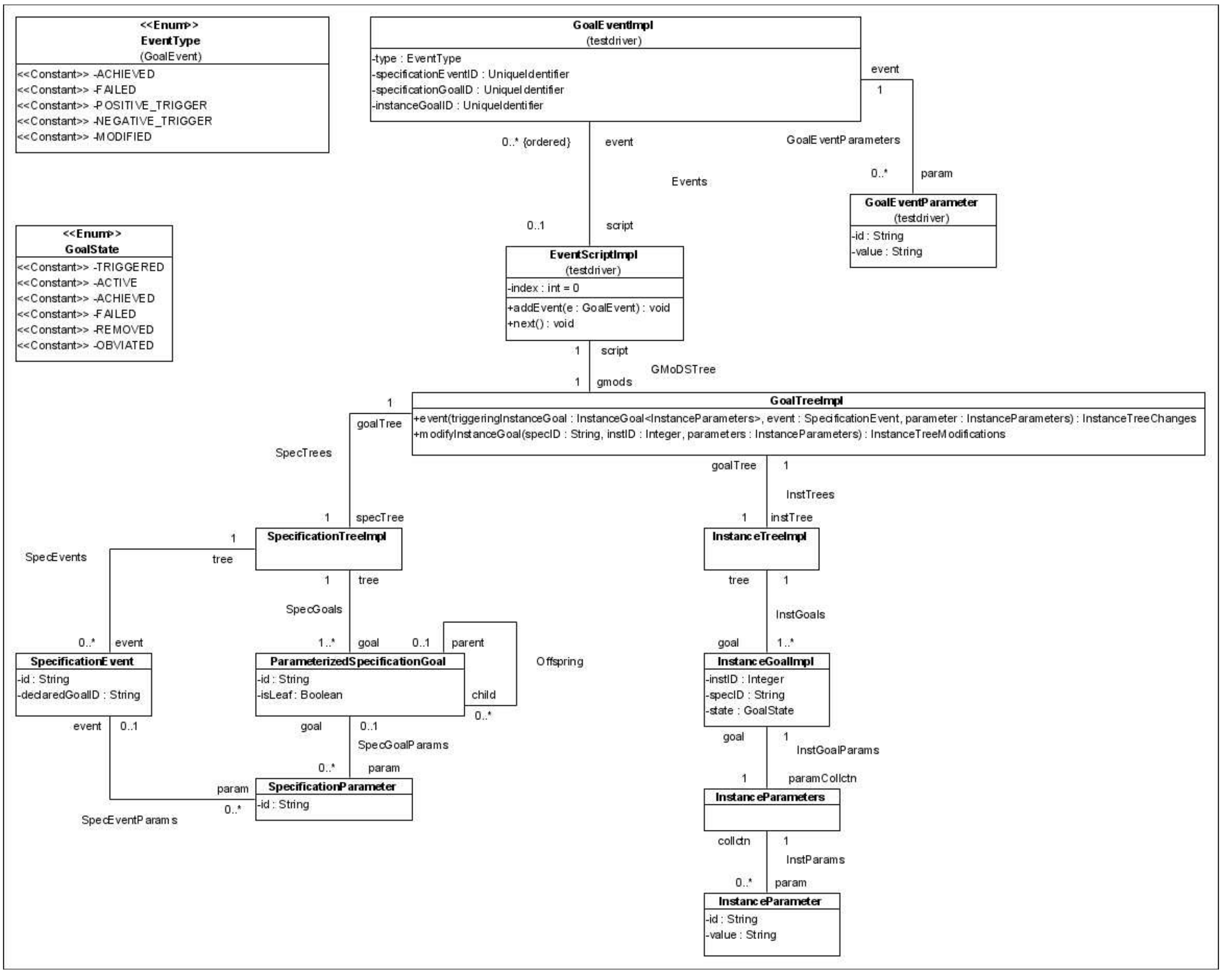


Figure 24 GMoDS and GMoDS Test Driver classes supporting formal specification

4.7 USE/OCL Model

```
-- GMoDS Test Driver Formal Specifications
--
-- GMoDSTestDriver.use
--
```

```
-- A formal specification of invariants maintained by EventScriptImpl
addEvent and next methods.
--
-- Author : Mike Fraka
-- Date: November 30, 2010
--

model GMoDSTestDriver

--
-- E N U M E R A T I O N S
--
enum EventType {ACHIEVED, FAILED, POSITIVE_TRIGGER, NEGATIVE_TRIGGER,
MODIFIED}
enum GoalState {TRIGGERED, ACTIVE, ACHIEVED, FAILED, REMOVED,
OBVIATED}


--
-- C L A S S E S
--
class GoalEventImpl
attributes
     type : EventType
     specEventID : String
     specGoalID : String
     instGoalID : Integer
end

class GoalEventParameter
attributes
    id : String
    value : String
end

class EventScriptImpl
attributes
    index : Integer
operations
    addEvent(e : GoalEventImpl)
    next()
end

class GoalTreeImpl
operations
    event(ig : InstanceGoalImpl, event : SpecificationEvent, param :
InstanceParameters)
    modifyInstanceGoal(specID : String, instID : Integer, param :
InstanceParameters)
end

class SpecificationTreeImpl end
class SpecificationEvent
attributes
    id : String
    declaredGoalID : String
end

class ParameterizedSpecificationGoal
attributes
    id : String
    isLeaf : Boolean
operations
    closureChildren(s : Set(ParameterizedSpecificationGoal)) :
Set(ParameterizedSpecificationGoal) =
      if s->includesAll(s.child->asSet()) then s
      else closureChildren(s->union(s.child->asSet()))
      endif
    descendantsAndSelf() : Set(ParameterizedSpecificationGoal) =
closureChildren(Set{self})
end

class SpecificationParameter
attributes
    id : String
end

class InstanceTreeImpl  end

class InstanceGoalImpl
attributes
    instID : Integer
    specID : String
    state : GoalState
end

class InstanceParameters end

class InstanceParameter
attributes
   id : String
   value : String
end
```

```
--
-- A S S O C I A T I O N S
--

-- GoalEventParameters: a GoalEventImpl has zero or more parameters
association GoalEventParameters between
  GoalEventImpl [1] role event
  GoalEventParameter [0..*] role param
end

-- Events: a EventScriptImpl has zero or more events
-- and a GoalEventImpl is associated with zero or one script.
association Events between
   EventScriptImpl [0..1] role script
   GoalEventImpl [0..*] role event ordered
end

-- GMoDSTree: a EventScriptImpl has 1 GoalTreeImpl
association GMoDSTree between
   EventScriptImpl [1] role script
   GoalTreeImpl [1] role gmods
end

-- SpecTrees: a GoalTreeImpl has 1 SpecificationTreeImpl
association SpecTrees between
   GoalTreeImpl [1] role goalTree
   SpecificationTreeImpl [1] role specTree
end

-- SpecEvents: a SpecificationTreeImpl has 0 or more
SpecificationEvents
association SpecEvents between
   SpecificationTreeImpl [1] role tree
   SpecificationEvent [0..*] role event
end

-- SpecGoals: a SpecificationTreeImpl has 1 or more
ParameterizedSpecificationGoals
association SpecGoals between
   SpecificationTreeImpl [1] role tree
   ParameterizedSpecificationGoal [1..*] role goal
end

-- Offspring: a ParametererizedSpecificationGoal has 0 or 1 parents
and
--  0 or more children
association Offspring between
   ParameterizedSpecificationGoal [0..1] role parent
   ParameterizedSpecificationGoal [0..*] role child
end
```

```
-- SpecEventParams: a SpecificationEvent has 0 or more
SpecificationParameters
association SpecEventParams between
   SpecificationEvent [0..1] role event
   SpecificationParameter [0..*] role param
end

-- SpecGoalParams: a ParameterizedSpecificationGoal has 0 or more
SpecificationParameters
association SpecGoalParams between
   ParameterizedSpecificationGoal [0..1] role goal
   SpecificationParameter [0..*] role param
end

-- InstTrees: a GoalTreeImpl has 1 InstanceTreeImpl
association InstTrees between
   GoalTreeImpl [1] role goalTree
   InstanceTreeImpl [1] role instTree
end

-- InstGoals: an InstanceTreeImpl has 1 or more InstanceGoalImpl
association InstGoals between
   InstanceTreeImpl [1] role tree
   InstanceGoalImpl [1..*] role goal
end

-- InstGoalParams: an InstanceGoalImpl has 1 InstanceParameters
association InstGoalParams between
   InstanceGoalImpl [1] role goal
   InstanceParameters [1] role paramCollctn
end

-- InstParams: an InstanceParameters has 0 or more InstanceParamter
objects
association InstParams between
   InstanceParameters [1] role collec
   InstanceParameter [0..*] role param
end

--
-- C O N S T R A I N T S
--

constraints

-- The index of the event script initially points to just before the
first event.
-- In Java, this is -1.
-- USE 2.6.2 does not support this legal OCL syntax
-- context EventScriptImpl::index
--    init: 0
```

```
context EventScriptImpl::addEvent(e : GoalEventImpl)
-- The event does not already exist in the script
  pre NotInScript: event->excludes(e)
-- The added event's type is valid
  pre ValidType:
      e.type = #ACHIEVED or e.type = #FAILED or
      e.type = #POSITIVE_TRIGGER or
      e.type = #NEGATIVE_TRIGGER or e.type = #MODIFIED
-- At least one parameter must be provided if type is #MODIFIED
  pre ModifiedReqParam: e.type = #MODIFIED implies e.param->size > 0
-- A #MODIFIED event's parameter names must match specification goal's
parameter names
  pre ValidModifiedParamNames:
      e.type = #MODIFIED and e.param->size > 0 implies
      e.param->forAll(ep | gmods.specTree.goal->exists(sg | sg.id =
e.specGoalID and
      sg.param->exists(sgp | sgp.id = ep.id)))
-- The added event refers to a ParameterizedSpecificationGoal that
-- exists in GMoDS' specification tree
  pre ValidSpecGoal:
   gmods.specTree.goal->exists(sg | sg.id = e.specGoalID)
-- An #ACHIEVED event will access the special 'ACHIEVED' event of
GMoDS and
-- must apply to a leaf specification goal.
  pre ValidAchievedEvent:
e.type = #ACHIEVED implies e.specEventID = 'ACHIEVED' and
      gmods.specTree.goal->exists(sg | sg.id = e.specGoalID and
sg.isLeaf = true)
-- A #FAILED event will access the special 'FAILED' event of GMoDS and
-- must apply to a leaf specification goal.
  pre ValidFailedEvent:
e.type = #FAILED implies e.specEventID = 'FAILED' and
      gmods.specTree.goal->exists(sg | sg.id = e.specGoalID and
sg.isLeaf = true)
-- If the type is #POSITIVE_TRIGGER or #NEGATIVE_TRIGGER
-- the added event refers to a SpecificationEvent that exists in GMoDS
specification tree,
-- the event's specification goal is a leaf goal, the event's
specification event's
-- declared goal exists, and the event's specification goal is either
the goal on which the
-- event was declared or a descendant of the declared goal.
  pre ValidSpecEvent:
e.type = #POSITIVE_TRIGGER or e.type = #NEGATIVE_TRIGGER implies
    (gmods.specTree.event->exists(se | se.id = e.specEventID and
                                  gmods.specTree.goal->exists(sg,dg |
sg.isLeaf = true and sg.id = e.specGoalID and dg.id =
se.declaredGoalID and dg.descendantsAndSelf()->includes(sg))))
```

```
-- if the type is #POSITIVE_TRIGGER or #NEGATIVE_TRIGGER
-- then it must provide the parameters required by the specification -
-- event
  pre ValidTriggerParamNames:
      e.type = #POSITIVE_TRIGGER or e.type = #NEGATIVE_TRIGGER implies
      (gmods.specTree.event->exists(se | se.id = e.specEventID and
       se.param->forAll(sep | e.param->exists(ep | ep.id = sep.id))))
-- The event is added to the script if all preconditions are met
  post NowInScript: event->includes(e)
-- The number of events is increased by 1
  post OneMoreEvent: (event->asSet - event@pre->asSet)->size = 1
-- The new event is appended to the end of the script
  post Appended: event->last = e

context EventScriptImpl::next()
-- The script must have at least 1 event
  pre HasAtLeastOneEvent: event->size > 0
-- The script has a next event to issue to GMoDS
  pre HasNextEvent: index < event->size
-- The next event refers to an InstanceGoal that exists in GMoDS
  pre ValidInstGoal: let nextEvt : GoalEventImpl = event->at(index +
1) in
      gmods.instTree.goal->exists(ig | ig.instID = nextEvt.instGoalID
and ig.specID = nextEvt.specGoalID)
-- An event whose type is not #MODIFIED must reference
-- an #ACTIVE InstanceGoal
  pre NotModifiedRefActiveGoal:
    let nextEvt : GoalEventImpl = event->at(index + 1) in
      nextEvt.type <> #MODIFIED implies
       gmods.instTree.goal->exists(ig | ig.instID = nextEvt.instGoalID
and                                     ig.specID = nextEvt.specGoalID
and                                     ig.state = #ACTIVE)
-- If the next event type is #NEGATIVE_TRIGGER then all of its
parameter
-- values must match an existing instance goal's parameter values
  pre ValidNegativeTrigger:
let nextEvt : GoalEventImpl = event->at(index + 1) in
nextEvt.type = #NEGATIVE_TRIGGER and nextEvt.param->size > 0 implies
gmods.instTree.goal->exists(ig | ig.instID = nextEvt.instGoalID and
                                 ig.specID = nextEvt.specGoalID and
 nextEvt.param->forAll( nep |
    ig.paramCollctn.param->exists(igp | igp.id = nep.id and
                                        igp.value = nep.value)))
-- Advance the script index
  post ScriptIndexAdvanced: index = index@pre + 1
-- If preconditions met and the next event is not #MODIFIED then
-- the 'event' message is sent to GMoDS with appropriate parameter
values.
  post NotModifiedSendsEvent:
     let nextEvt : GoalEventImpl = event->at(index@pre + 1)
         in
        (nextEvt.type <> #MODIFIED implies
          (let
               instParams : InstanceParameters =
 gmods.instTree.goal->any(ig | ig.instID = nextEvt.instGoalID and
                         ig.specID = nextEvt.specGoalID).paramCollctn
-- USE 2.6.2 would not accept these additional local variable
declarations needed to specify the message sent in the next method.
--           ,
--              instGoal : InstanceGoalImpl =
--  gmods.instTree.goal->any(ig | ig.instID = nextEvt.instGoalID and
--                               ig.specID = nextEvt.specGoalID),
--              specEvt : SpecificationEvent =
--        gmods.specTree.event->any(se | se.id = nextEvt.specEventID)
             in
  instParams.oclIsNew() and
nextEvt.param->forAll(np | instParams.param->exists(ip | ip.oclIsNew()
and ip.id = np.id and ip.value = np.value))
-- USE 2.6.2 does not appear to support the "isSent" operator denoted
by "^" in Warmer and Kleppe "The Object Constraint Language", 2nd
Edition, 2003, Addison Wesley, pp. 156-157.
-- and gmods^event(instGoal, specEvt, instParams)
             ))
-- If preconditions are met and the next event is #MODIFIED then the
-- 'modifyInstanceGoal' message is sent to GMoDS with appropriate
parameter values.
  post ModifiedSendsModifyInstanceGoal:
     let nextEvt : GoalEventImpl = event->at(index@pre + 1)
         in
        (nextEvt.type = #MODIFIED implies
          (let
               instParams : InstanceParameters =
            gmods.instTree.goal->any(ig | ig.instID =
nextEvt.instGoalID and
                                             ig.specID =
nextEvt.specGoalID).paramCollctn
             in
             instParams.oclIsNew() and
                nextEvt.param->forAll(np | instParams.param->exists(ip
| ip.oclIsNew() and

ip.id = np.id and

ip.value = np.value))
-- USE 2.6.2 does not appear to support the "isSent" operator denoted
by "^" in
-- Warmer and Kleppe "The Object Constraint Language", 2nd Edition,
2003, Addison Wesley, pp. 156-157.
-- and gmods^modifyInstanceGoal(nextEvt.specGoalID,
nextEvt.instGoalID, instParams)
             ))
```

5 Chapter 5 Technical Inspection Check List

5.1 Introduction

5.2 Items to Inspect

5.2.1 System Architecture Design Document 1.0

1. System Architecture (Section 4.2)
    a. System Components (Section 4.2.1)
    b. System Component Responsibilities (Section 4.2.2)
    c. System Interface Specifications (Section 4.2.3)
    d. System Architecture Design Rationale (Section 4.2.4)
2. GMoDS Test Driver Architecture (Section 4.3)
    a. GMoDS Test Driver Decomposition Class Diagram (Section 4.3.1)
    b. GMoDS Test Driver Module Responsibilities (Section 4.3.2)
    c. GMoDS Test Driver Interface Specifications (Section 4.3.3)
    d. GMoDS Test Driver Design Rationale (Section 4.3.4)
3. GMoDS Architecture (Section 4.6)
4. USE/OCL Model (Section 4.7)

5.3 Inspectors

- Shylaja Chippa
- Kyle Hill

5.4 Formal Inspection Check List

Table 26 Formal Inspection Check List

Inspection Item	Pass/Fail/Partial	Comments
The system component diagram (Figure 2) uses legal UML elements.		
Section 4.1 clearly explains the elements of the system component diagram.		
Table 1 clearly explains the responsibilities of each system component.		
Table 2 clearly specifies the GMoDS Test Driver main		

Inspection Item	Pass/Fail/Partial	Comments
program interface.		
Table 3 clearly specifies the GMoDSVisualizer interface.		
Table 4 clearly specifies the TestDriver interface.		
Section 4.4 clearly explains the rationale for the system architecture.		
The GMoDS Test Driver architectural module class diagram (Figure 3) uses legal UML elements.		
Table 5 clearly explains the responsibility of each GMoDS Test Driver architectural class or interface (Note: GoalTree is a GMoDS interface not a GMoDS Test Driver interface).		
Table 6 clearly specifies the GoalEvent interface.		
Table 7 clearly specifies the EventScript interface.		
Section 5.1.3 clearly explains the rationale for the GMoDS Test Driver architecture.		
The GMoDS architectural class diagram (Figure 14) uses legal UML elements.		
Section 8 clearly explains the rationale for Figure 14 elements.		
Classes in the USE/OCL model (section 9) are consistent with the classes in Figure 14.		

Inspection Item	Pass/Fail/Partial	Comments
Attributes in the USE/OCL model (section 9) are consistent with the corresponding classes in Figure 14.		
Associations in the USE/OCL model (section 9) are consistent with associations in Figure 14.		
Multiplicities in the USE/OCL model (section 9) are consistent with multiplicities on the corresponding associations in Figure 14.		

6 Chapter 6 USE/OCL Modeling of the Formal Specification

6.1 Introduction

This documents the validation of the formal specification of the method EventScriptImpl::addEvent with USE version 2.6.2.

6.2 USE Modeling

An action item from MSE presentation 2 was:

- Perform USE/OCL modeling of state snapshots to validate the pre and post conditions of the EventScriptImpl::next method in the formal specification.

I performed this modeling using USE 2.6.2.

6.3 Limitations of USE 2.6.2

USE 2.6.2 does not support the OCL "isSent" operator (denoted '^') necessary for the most important post conditions of the EventScriptImpl::next method. A MODIFIED event type causes the next method to send the message "modifyInstanceGoal" to GMoDS, and all other event types cause the next method to send the message "event". In addition, USE 2.6.2 does not support the "init" constraint on a class attribute. Finally, I was unable to get USE 2.6.2 to allow more than 1 local variable to be defined in a "let" expression.

As a result of these limitations, I requested and was granted permission to model the EventScriptImpl::addEvent method.

6.4 Modeling EventScriptImpl::addEvent in USE

Table 27 below lists the scripts contained in [10] that I used to model the formal specification of the method EventScriptImpl::addEvent.

Table 27 USE scripts modeling EventScriptImpl::addEvent

Script	Comment	Figure
GTD.use	OSE class, association, and constraint model	Figure 24
gtd-valid-pt.cmd	Snapshot of pre state adding a valid #POSITIVE_TRIGGER	Figure 25
gtd-valid-post.cmd	Script to invoke pre/post conditions (valid post conditions)	Figure 26
gtd-invalid-post.cmd	Script that invokes pre/post conditions (invalid post conditions)	Figure 27
gtd-invalid-specevt.cmd	Snapshot of pre state adding an invalid #POSITIVE_TRIGGER due to an invalid SpecificationEvent ID.	Figure 29

Script	Comment	Figure
gtd-invalid-specgoal.cmd	Snapshot of pre state adding an invalid #POSTIVE_TRIGGER due to an invalid ParamterizedSpecificationGoal ID.	Figure 30
gtd-invalid-achieved.cmd	Snapshot of pre state adding an invalid #ACHIEVED event due to referencing a non-leaf goal.	Figure 31
gtd-invalid-modified.cmd	Snapshot of pre state adding an invalid #MODIFIED event due to no parameters specified.	Figure 32 Figure 33
gtd-valid-modified.cmd	Snapshot of pre state adding a valid #MODIFIED event.	Figure 34 Figure 35
gtd-invalid-modified-paramnames.cmd	Snapshot of pre state adding an invalid #MODIFIED event due to mismatch on parameter names.	Figure 36

6.4.1 Modeling a POSITIVE_TRIGGER event

Figure 25 below shows an object diagram of a pre state when adding a valid #POSITIVE_TRIGGER event.

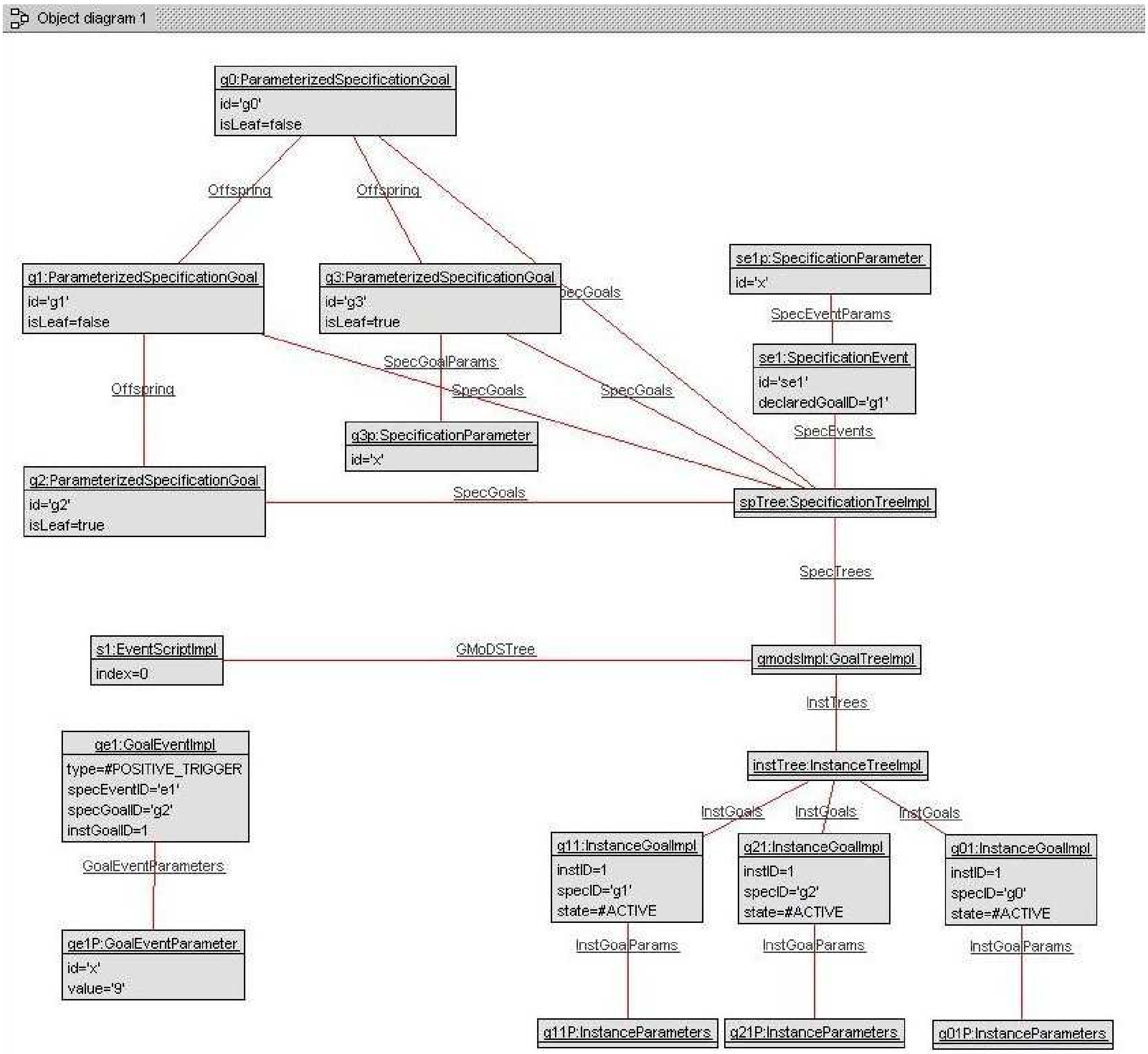
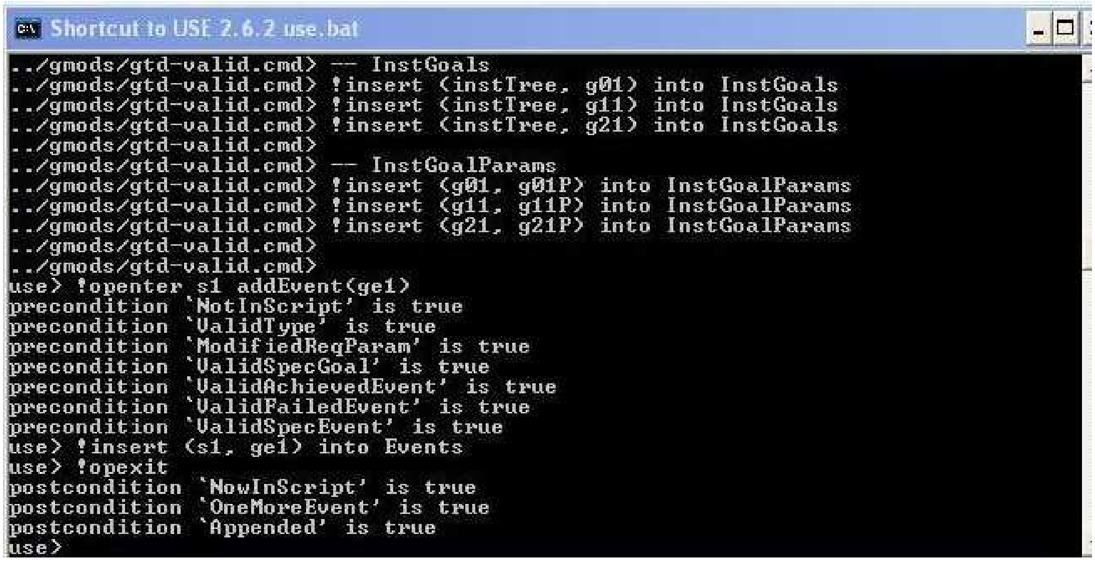


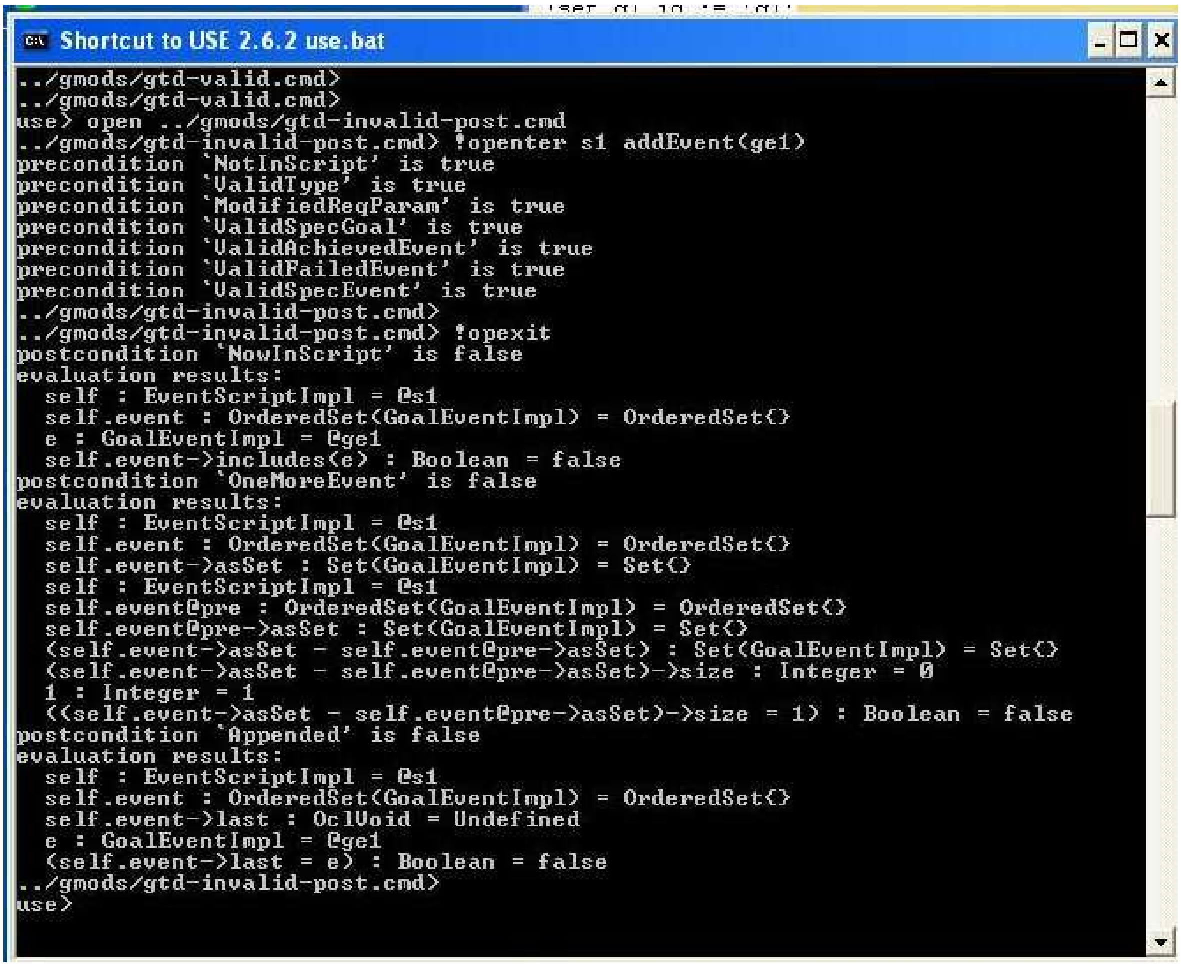
Figure 25 Valid snapshot prior to adding a POSITIVE_TRIGGER event

Figure 26 below shows that the pre conditions and post conditions are valid for the above snapshot when executing the script gtd-valid-post.cmd manually.



```
../gmods/gtd-valid.cmd> -- InstGoals
../gmods/gtd-valid.cmd> !insert (instTree, g01) into InstGoals
../gmods/gtd-valid.cmd> !insert (instTree, g11) into InstGoals
../gmods/gtd-valid.cmd> !insert (instTree, g21) into InstGoals
../gmods/gtd-valid.cmd>
../gmods/gtd-valid.cmd> -- InstGoalParams
../gmods/gtd-valid.cmd> !insert (g01, g01P) into InstGoalParams
../gmods/gtd-valid.cmd> !insert (g11, g11P) into InstGoalParams
../gmods/gtd-valid.cmd> !insert (g21, g21P) into InstGoalParams
../gmods/gtd-valid.cmd>
../gmods/gtd-valid.cmd>
use> !openter s1 addEvent(ge1)
precondition `NotInScript' is true
precondition `ValidType' is true
precondition `ModifiedReqParam' is true
precondition `ValidSpecGoal' is true
precondition `ValidAchievedEvent' is true
precondition `ValidFailedEvent' is true
precondition `ValidSpecEvent' is true
use> !insert (s1, ge1) into Events
use> !opexit
postcondition `NowInScript' is true
postcondition `OneMoreEvent' is true
postcondition `Appended' is true
use>
```

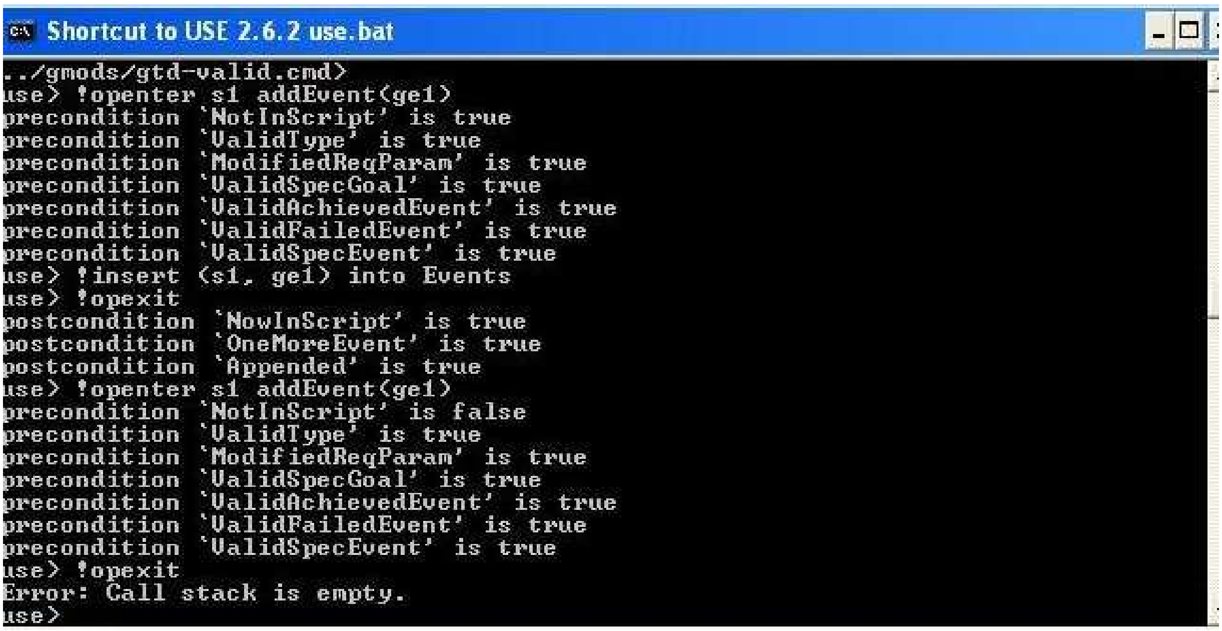
Figure 26 Valid pre/post conditions when adding a POSITIVE_TRIGGER event



```
../gmods/gtd-valid.cmd>
../gmods/gtd-valid.cmd>
use> open ../gmods/gtd-invalid-post.cmd
../gmods/gtd-invalid-post.cmd> !openter s1 addEvent(ge1)
precondition `NotInScript' is true
precondition `ValidType' is true
precondition `ModifiedReqParam' is true
precondition `ValidSpecGoal' is true
precondition `ValidAchievedEvent' is true
precondition `ValidFailedEvent' is true
precondition `ValidSpecEvent' is true
../gmods/gtd-invalid-post.cmd>
../gmods/gtd-invalid-post.cmd> !opexit
postcondition `NowInScript' is false
evaluation results:
  self : EventScriptImpl = @s1
  self.event : OrderedSet(GoalEventImpl) = OrderedSet{}
  e : GoalEventImpl = @ge1
  self.event->includes(e) : Boolean = false
postcondition `OneMoreEvent' is false
evaluation results:
  self : EventScriptImpl = @s1
  self.event : OrderedSet(GoalEventImpl) = OrderedSet{}
  self.event->asSet : Set(GoalEventImpl) = Set{}
  self : EventScriptImpl = @s1
  self.event@pre : OrderedSet(GoalEventImpl) = OrderedSet{}
  self.event@pre->asSet : Set(GoalEventImpl) = Set{}
  (self.event->asSet - self.event@pre->asSet) : Set(GoalEventImpl) = Set{}
  (self.event->asSet - self.event@pre->asSet)->size : Integer = 0
  1 : Integer = 1
  ((self.event->asSet - self.event@pre->asSet)->size = 1) : Boolean = false
postcondition `Appended' is false
evaluation results:
  self : EventScriptImpl = @s1
  self.event : OrderedSet(GoalEventImpl) = OrderedSet{}
  self.event->last : OclVoid = Undefined
  e : GoalEventImpl = @ge1
  (self.event->last = e) : Boolean = false
../gmods/gtd-invalid-post.cmd>
use>
```

Figure 27 Invalid post conditions

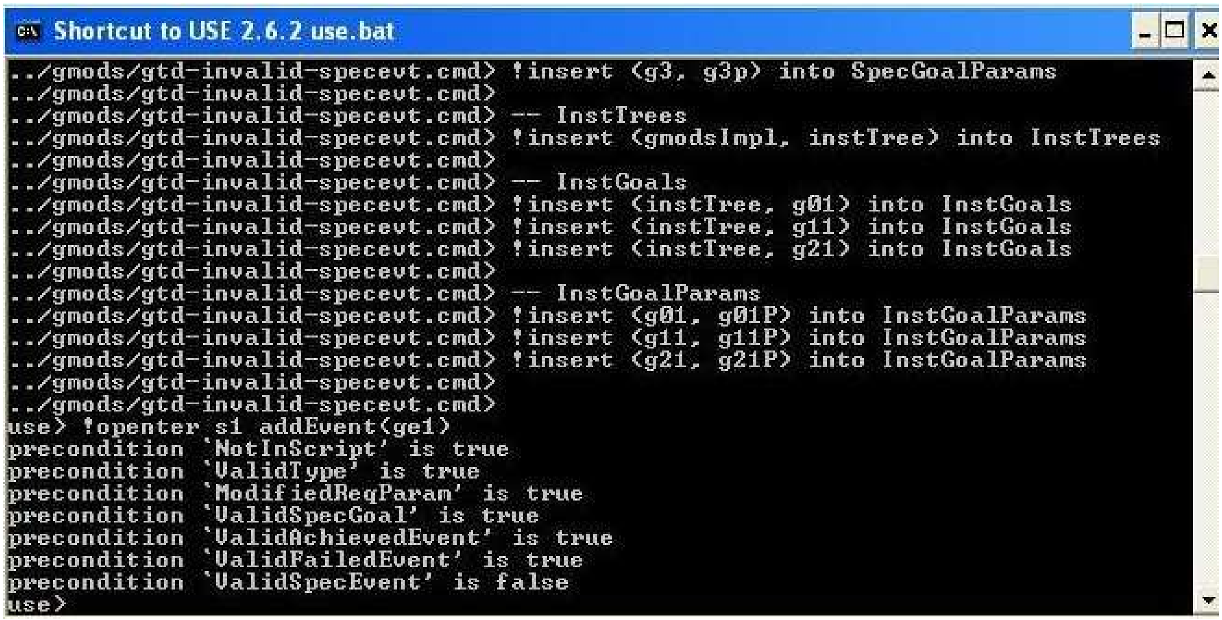
Figure 27 above shows that the post conditions are violated in the above snapshot if the script gtd-invalid-post.cmd is executed.



```
../gmods/gtd-valid.cmd>
use> !openter s1 addEvent(ge1)
precondition `NotInScript' is true
precondition `ValidType' is true
precondition `ModifiedReqParam' is true
precondition `ValidSpecGoal' is true
precondition `ValidAchievedEvent' is true
precondition `ValidFailedEvent' is true
precondition `ValidSpecEvent' is true
use> !insert (s1, ge1) into Events
use> !opexit
postcondition `NowInScript' is true
postcondition `OneMoreEvent' is true
postcondition `Appended' is true
use> !openter s1 addEvent(ge1)
precondition `NotInScript' is false
precondition `ValidType' is true
precondition `ModifiedReqParam' is true
precondition `ValidSpecGoal' is true
precondition `ValidAchievedEvent' is true
precondition `ValidFailedEvent' is true
precondition `ValidSpecEvent' is true
use> !opexit
Error: Call stack is empty.
use>
```

Figure 28 Invalid already in script

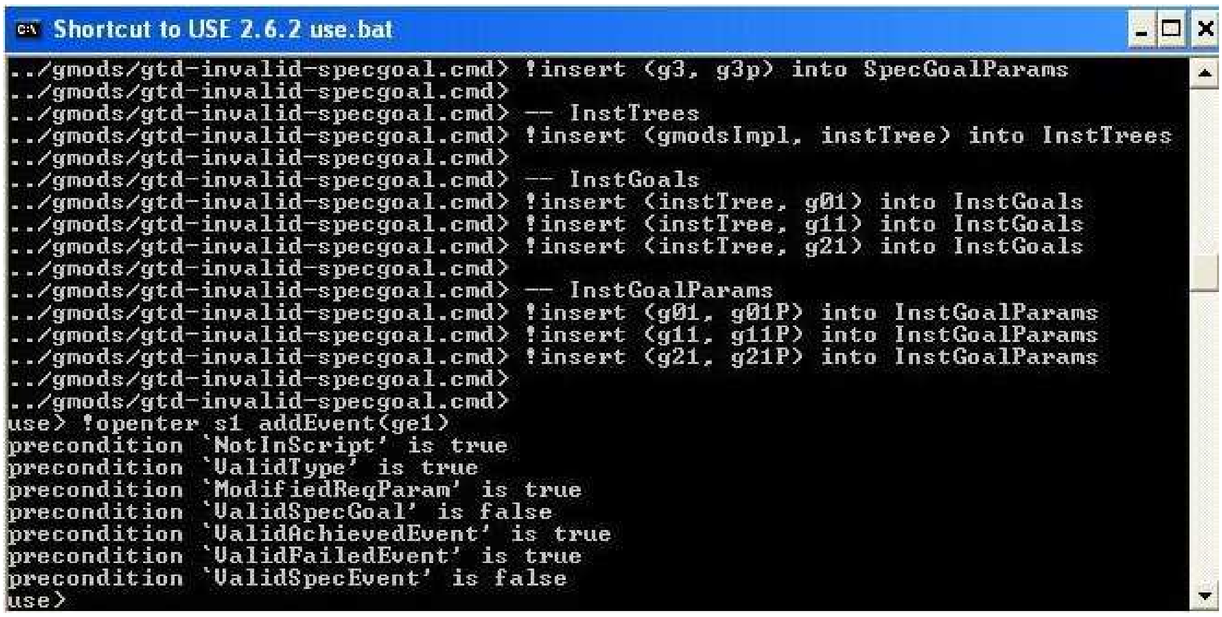
Figure 28 above shows that executing addEvent twice for the same event violates the “NotInScript” precondition.



```
../gmods/gtd-invalid-specevt.cmd> !insert (g3, g3p) into SpecGoalParams
../gmods/gtd-invalid-specevt.cmd>
../gmods/gtd-invalid-specevt.cmd> -- InstTrees
../gmods/gtd-invalid-specevt.cmd> !insert (gmodsImpl, instTree) into InstTrees
../gmods/gtd-invalid-specevt.cmd>
../gmods/gtd-invalid-specevt.cmd> -- InstGoals
../gmods/gtd-invalid-specevt.cmd> !insert (instTree, g01) into InstGoals
../gmods/gtd-invalid-specevt.cmd> !insert (instTree, g11) into InstGoals
../gmods/gtd-invalid-specevt.cmd> !insert (instTree, g21) into InstGoals
../gmods/gtd-invalid-specevt.cmd>
../gmods/gtd-invalid-specevt.cmd> -- InstGoalParams
../gmods/gtd-invalid-specevt.cmd> !insert (g01, g01P) into InstGoalParams
../gmods/gtd-invalid-specevt.cmd> !insert (g11, g11P) into InstGoalParams
../gmods/gtd-invalid-specevt.cmd> !insert (g21, g21P) into InstGoalParams
../gmods/gtd-invalid-specevt.cmd>
../gmods/gtd-invalid-specevt.cmd>
use> !openter s1 addEvent(ge1)
precondition `NotInScript' is true
precondition `ValidType' is true
precondition `ModifiedReqParam' is true
precondition `ValidSpecGoal' is true
precondition `ValidAchievedEvent' is true
precondition `ValidFailedEvent' is true
precondition `ValidSpecEvent' is false
use>
```

Figure 29 Invalid SpecificationEvent

Figure 29 above shows that the script gtd-invalid-specevt.cmd violates the “ValidSpecEvent” pre condition.

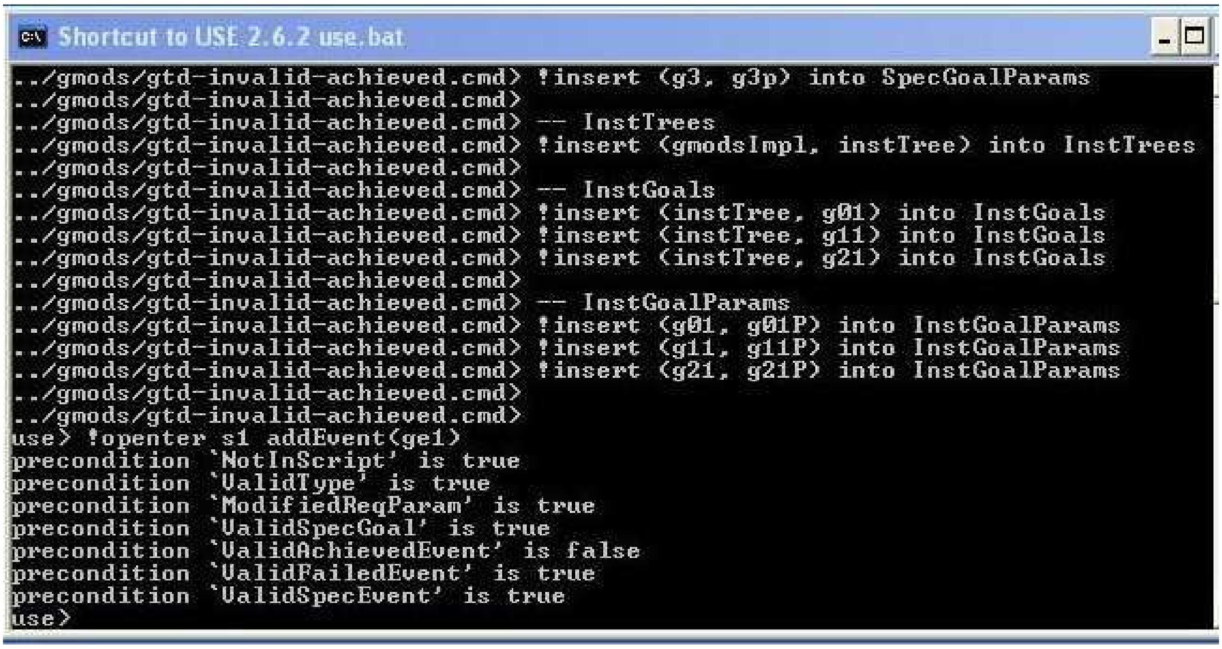


```
../gmods/gtd-invalid-specgoal.cmd> !insert (g3, g3p) into SpecGoalParams
../gmods/gtd-invalid-specgoal.cmd>
../gmods/gtd-invalid-specgoal.cmd> -- InstTrees
../gmods/gtd-invalid-specgoal.cmd> !insert (gmodsImpl, instTree) into InstTrees
../gmods/gtd-invalid-specgoal.cmd>
../gmods/gtd-invalid-specgoal.cmd> -- InstGoals
../gmods/gtd-invalid-specgoal.cmd> !insert (instTree, g01) into InstGoals
../gmods/gtd-invalid-specgoal.cmd> !insert (instTree, g11) into InstGoals
../gmods/gtd-invalid-specgoal.cmd> !insert (instTree, g21) into InstGoals
../gmods/gtd-invalid-specgoal.cmd>
../gmods/gtd-invalid-specgoal.cmd> -- InstGoalParams
../gmods/gtd-invalid-specgoal.cmd> !insert (g01, g01P) into InstGoalParams
../gmods/gtd-invalid-specgoal.cmd> !insert (g11, g11P) into InstGoalParams
../gmods/gtd-invalid-specgoal.cmd> !insert (g21, g21P) into InstGoalParams
../gmods/gtd-invalid-specgoal.cmd>
../gmods/gtd-invalid-specgoal.cmd>
use> !openter s1 addEvent(ge1)
precondition `NotInScript' is true
precondition `ValidType' is true
precondition `ModifiedReqParam' is true
precondition `ValidSpecGoal' is false
precondition `ValidAchievedEvent' is true
precondition `ValidFailedEvent' is true
precondition `ValidSpecEvent' is false
use>
```

Figure 30 Invalid SpecificationGoal

Figure 30 above shows the script gtd-invalid-specgoal.cmd violates the “ValidSpecGoal” and “ValidSpecEvent” pre conditions.

6.4.2 Modeling an ACHIEVED event



```
../gmods/gtd-invalid-achieved.cmd> !insert (g3, g3p) into SpecGoalParams
../gmods/gtd-invalid-achieved.cmd>
../gmods/gtd-invalid-achieved.cmd> -- InstTrees
../gmods/gtd-invalid-achieved.cmd> !insert (gmodsImpl, instTree) into InstTrees
../gmods/gtd-invalid-achieved.cmd>
../gmods/gtd-invalid-achieved.cmd> -- InstGoals
../gmods/gtd-invalid-achieved.cmd> !insert (instTree, g01) into InstGoals
../gmods/gtd-invalid-achieved.cmd> !insert (instTree, g11) into InstGoals
../gmods/gtd-invalid-achieved.cmd> !insert (instTree, g21) into InstGoals
../gmods/gtd-invalid-achieved.cmd>
../gmods/gtd-invalid-achieved.cmd> -- InstGoalParams
../gmods/gtd-invalid-achieved.cmd> !insert (g01, g01P) into InstGoalParams
../gmods/gtd-invalid-achieved.cmd> !insert (g11, g11P) into InstGoalParams
../gmods/gtd-invalid-achieved.cmd> !insert (g21, g21P) into InstGoalParams
../gmods/gtd-invalid-achieved.cmd>
../gmods/gtd-invalid-achieved.cmd>
use> !openter s1 addEvent(ge1)
precondition `NotInScript' is true
precondition `ValidType' is true
precondition `ModifiedReqParam' is true
precondition `ValidSpecGoal' is true
precondition `ValidAchievedEvent' is false
precondition `ValidFailedEvent' is true
precondition `ValidSpecEvent' is true
use>
```

Figure 31 Invalid ACHIEVED event

Figure 31 above shows that the script gtd-invalid-achieved.cmd violates the “ValidAchievedEvent” pre condition. A slight modification of this script would violate the “ValidFailedEvent” pre condition.

6.4.3 Modeling a MODIFIED event

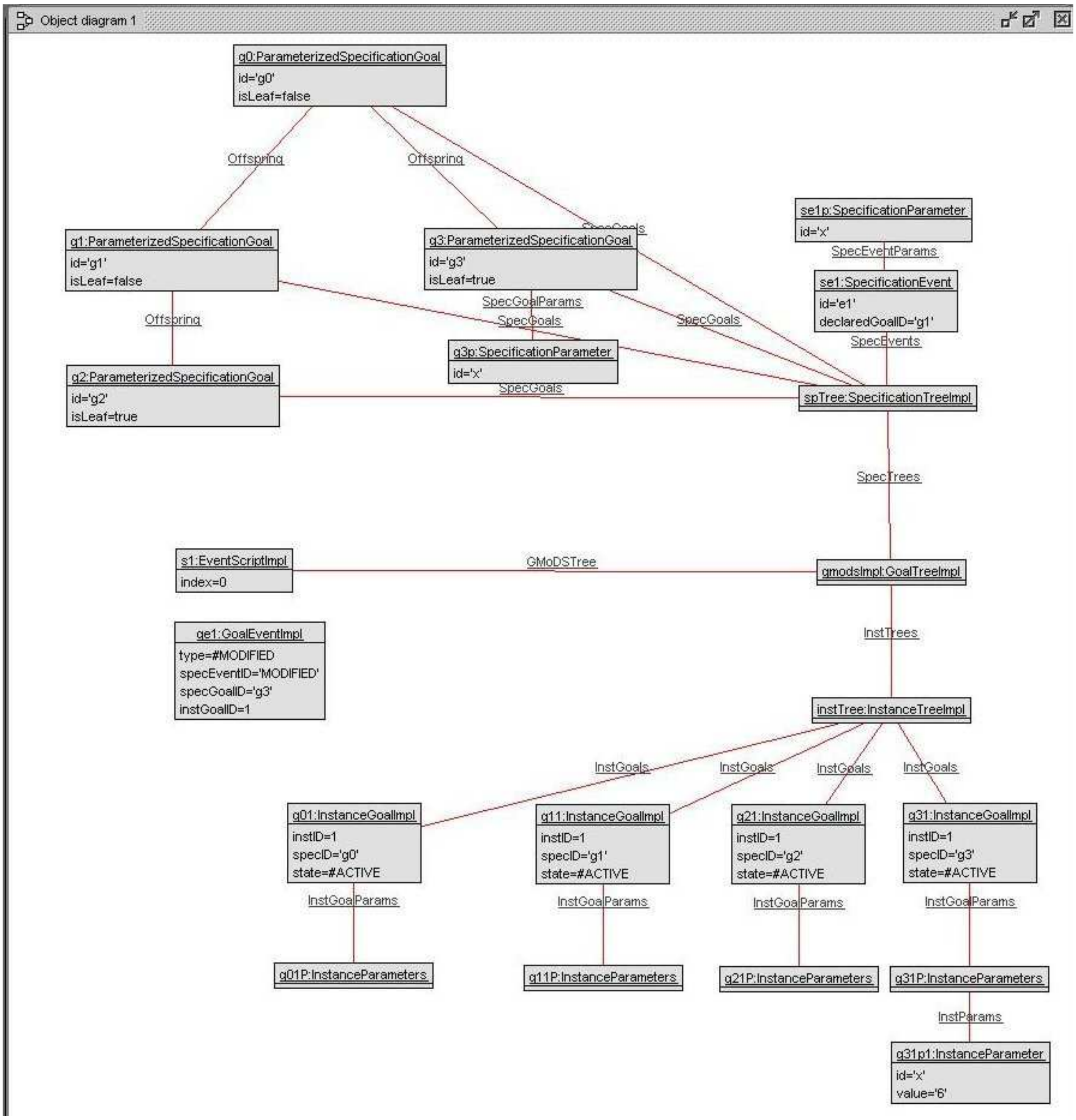
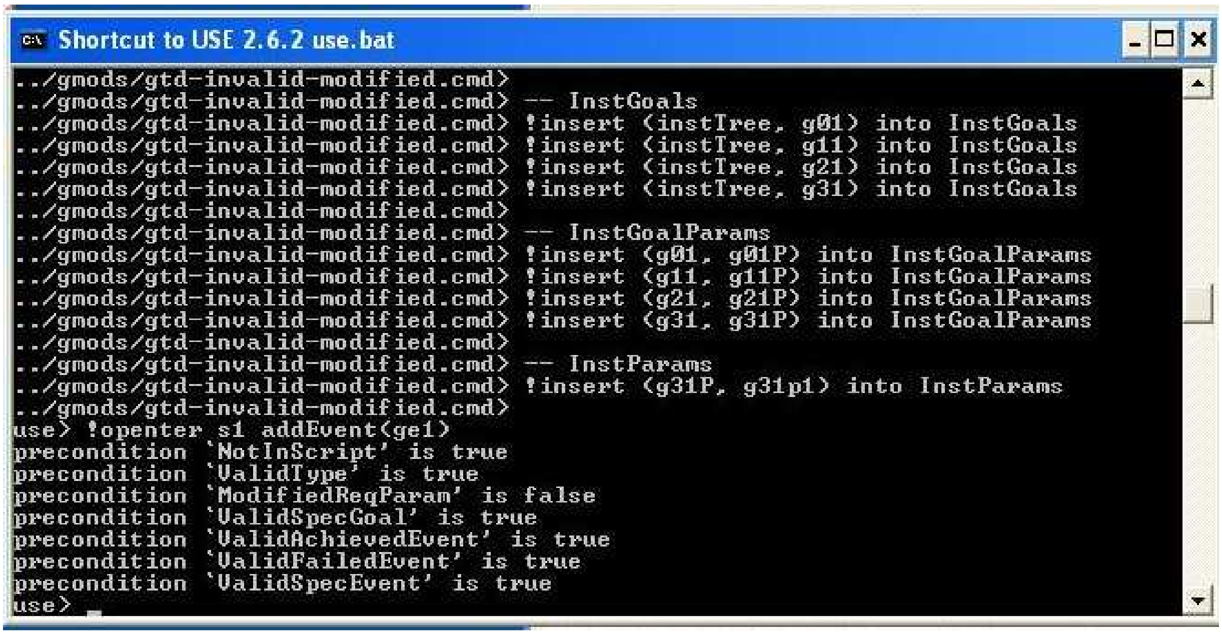


Figure 32 Valid snapshot prior to adding an invalid MODIFIED event with no parameters

Figure 32 above shows a snapshot of an invalid #MODIFIED event which is invalid because it specifies no parameters.



```
../gmods/gtd-invalid-modified.cmd>
../gmods/gtd-invalid-modified.cmd> -- InstGoals
../gmods/gtd-invalid-modified.cmd> !insert (instTree, g01) into InstGoals
../gmods/gtd-invalid-modified.cmd> !insert (instTree, g11) into InstGoals
../gmods/gtd-invalid-modified.cmd> !insert (instTree, g21) into InstGoals
../gmods/gtd-invalid-modified.cmd> !insert (instTree, g31) into InstGoals
../gmods/gtd-invalid-modified.cmd>
../gmods/gtd-invalid-modified.cmd> -- InstGoalParams
../gmods/gtd-invalid-modified.cmd> !insert (g01, g01P) into InstGoalParams
../gmods/gtd-invalid-modified.cmd> !insert (g11, g11P) into InstGoalParams
../gmods/gtd-invalid-modified.cmd> !insert (g21, g21P) into InstGoalParams
../gmods/gtd-invalid-modified.cmd> !insert (g31, g31P) into InstGoalParams
../gmods/gtd-invalid-modified.cmd>
../gmods/gtd-invalid-modified.cmd> -- InstParams
../gmods/gtd-invalid-modified.cmd> !insert (g31P, g31p1) into InstParams
../gmods/gtd-invalid-modified.cmd>
use> !openter s1 addEvent(ge1)
precondition `NotInScript' is true
precondition `ValidType' is true
precondition `ModifiedReqParam' is false
precondition `ValidSpecGoal' is true
precondition `ValidAchievedEvent' is true
precondition `ValidFailedEvent' is true
precondition `ValidSpecEvent' is true
use>
```

Figure 33 Invalid MODIFIED event with no parameters

Figure 33 above shows that invoking the addEvent violates the “ModifiedReqParam” pre condition for the above snapshot.

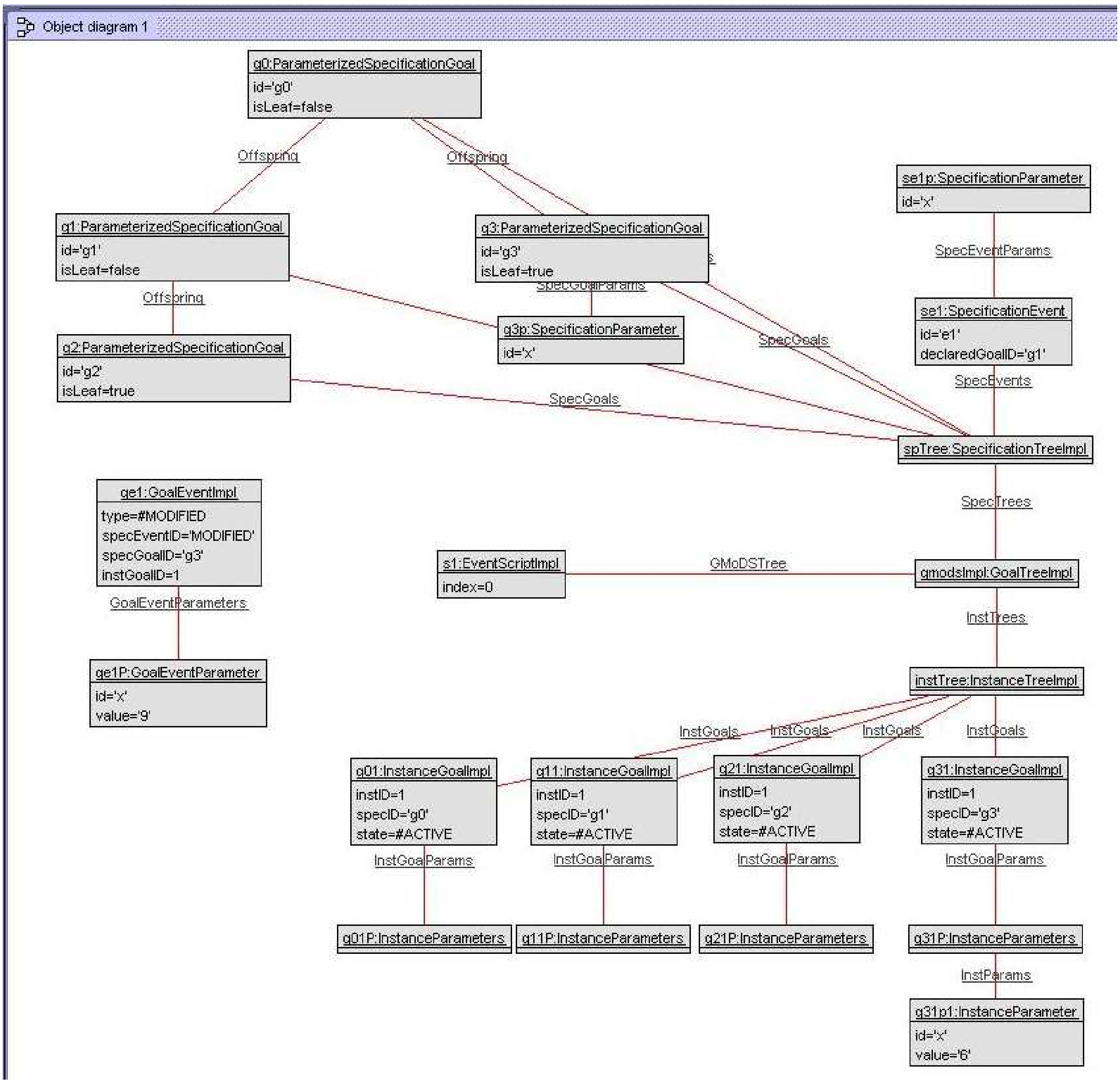
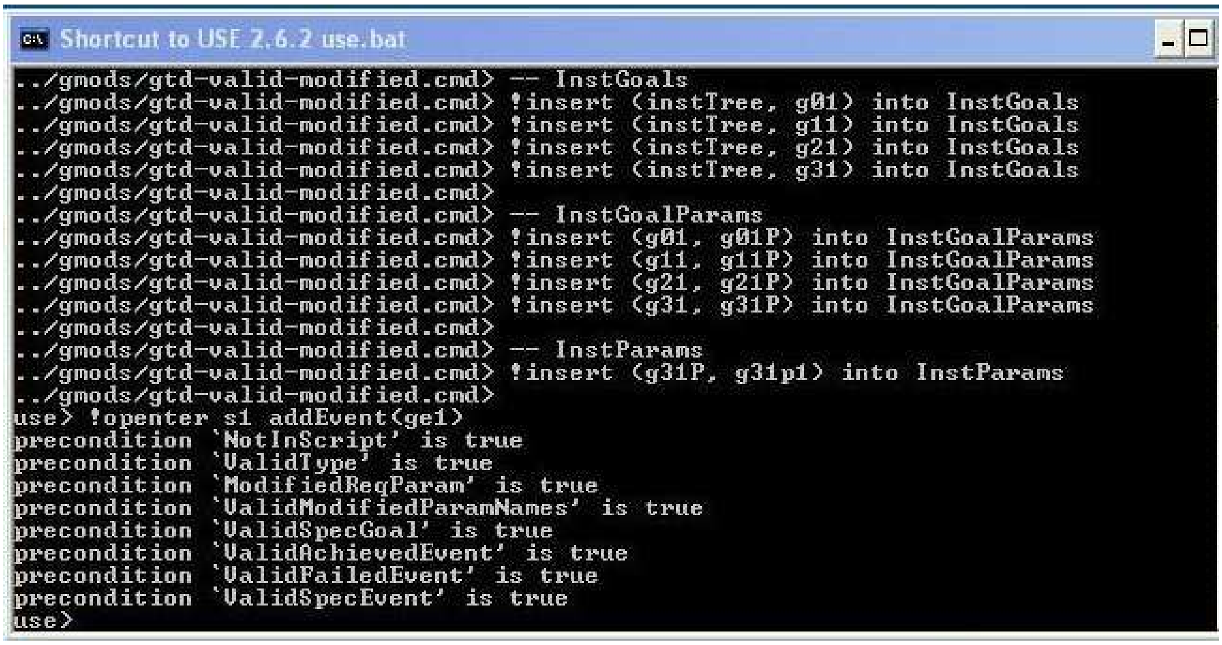


Figure 34 Valid snapshot prior to adding a valid MODIFIED event with parameters

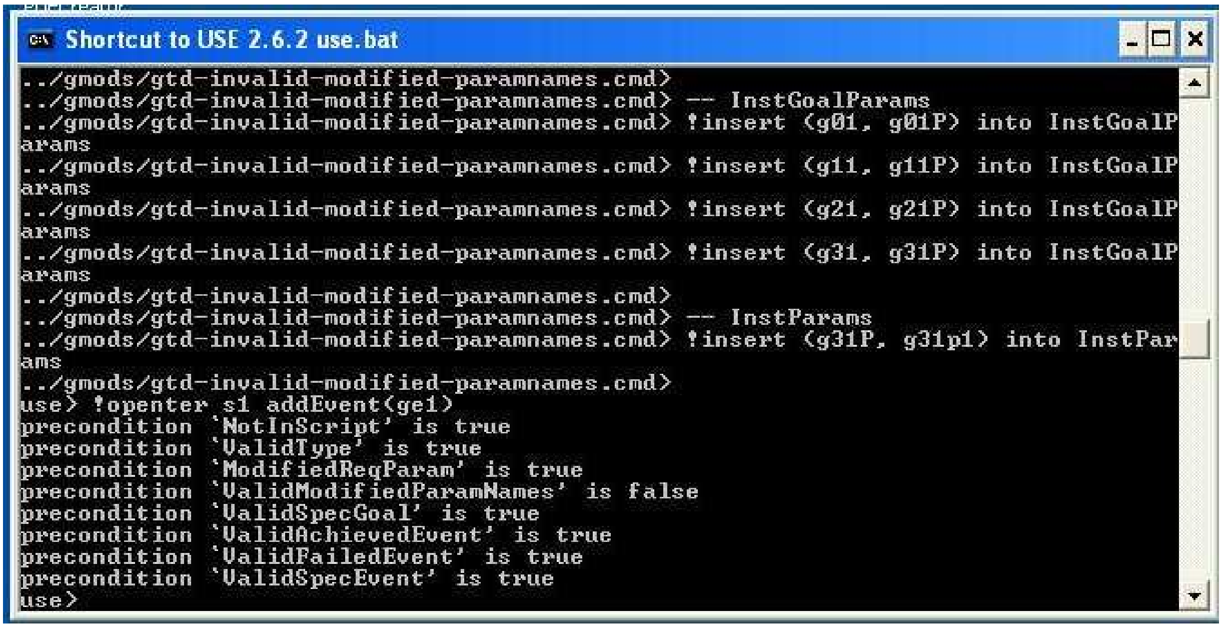
Figure 34 above shows a snapshot of the pre state when adding a valid #MODIFIED event. Figure 35 below shows that invoking addEvent on this snapshot produces valid pre conditions.



```
../gmods/gtd-valid-modified.cmd> -- InstGoals
../gmods/gtd-valid-modified.cmd> !insert (instTree, g01) into InstGoals
../gmods/gtd-valid-modified.cmd> !insert (instTree, g11) into InstGoals
../gmods/gtd-valid-modified.cmd> !insert (instTree, g21) into InstGoals
../gmods/gtd-valid-modified.cmd> !insert (instTree, g31) into InstGoals
../gmods/gtd-valid-modified.cmd>
../gmods/gtd-valid-modified.cmd> -- InstGoalParams
../gmods/gtd-valid-modified.cmd> !insert (g01, g01P) into InstGoalParams
../gmods/gtd-valid-modified.cmd> !insert (g11, g11P) into InstGoalParams
../gmods/gtd-valid-modified.cmd> !insert (g21, g21P) into InstGoalParams
../gmods/gtd-valid-modified.cmd> !insert (g31, g31P) into InstGoalParams
../gmods/gtd-valid-modified.cmd>
../gmods/gtd-valid-modified.cmd> -- InstParams
../gmods/gtd-valid-modified.cmd> !insert (g31P, g31p1) into InstParams
../gmods/gtd-valid-modified.cmd>
use> !openter s1 addEvent(ge1)
precondition `NotInScript' is true
precondition `ValidType' is true
precondition `ModifiedReqParam' is true
precondition `ValidModifiedParamNames' is true
precondition `ValidSpecGoal' is true
precondition `ValidAchievedEvent' is true
precondition `ValidFailedEvent' is true
precondition `ValidSpecEvent' is true
use>
```

Figure 35 Valid pre conditions adding a MODIFIED event

Figure 36 below shows that the script gtd-invalid-modifed-paramnames.cmd violates the “ValidModifiedParamNames” pre condition.



```
../gmods/gtd-invalid-modified-paramnames.cmd>
../gmods/gtd-invalid-modified-paramnames.cmd> -- InstGoalParams
../gmods/gtd-invalid-modified-paramnames.cmd> !insert (g01, g01P) into InstGoalP
arams
../gmods/gtd-invalid-modified-paramnames.cmd> !insert (g11, g11P) into InstGoalP
arams
../gmods/gtd-invalid-modified-paramnames.cmd> !insert (g21, g21P) into InstGoalP
arams
../gmods/gtd-invalid-modified-paramnames.cmd> !insert (g31, g31P) into InstGoalP
arams
../gmods/gtd-invalid-modified-paramnames.cmd>
../gmods/gtd-invalid-modified-paramnames.cmd> -- InstParams
../gmods/gtd-invalid-modified-paramnames.cmd> !insert (g31P, g31p1) into InstPar
ams
../gmods/gtd-invalid-modified-paramnames.cmd>
use> !openter s1 addEvent(ge1)
precondition `NotInScript' is true
precondition `ValidType' is true
precondition `ModifiedReqParam' is true
precondition `ValidModifiedParamNames' is false
precondition `ValidSpecGoal' is true
precondition `ValidAchievedEvent' is true
precondition `ValidFailedEvent' is true
precondition `ValidSpecEvent' is true
use>
```

Figure 36 Invalid parameter name in a MODIFIED event

7 Chapter 7 Component Design

7.1 *Introduction*

This is the component design for the GMoDS Visualizer and Test Driver Masters of Software Engineering final project.

7.2 *Component Design*

This section documents the detailed design of each system component.

7.2.1 GMoDS Test Driver Component Design

This section documents the detailed static and behavioral design of the GMoDS Test Driver component.

7.2.1.1 GMoDS Test Driver Static Structure

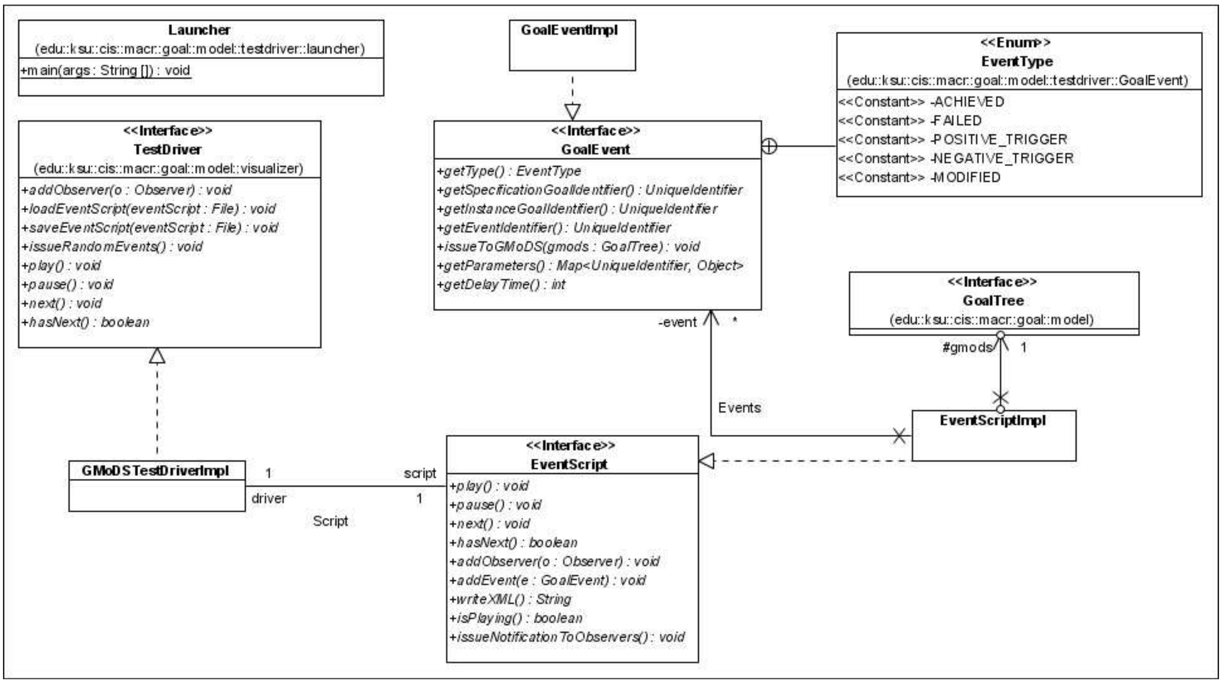

Launcher
(edu::ksu::cis::macr::goal::model::testdriver::launcher)
+main(args : String []) : void
GoalEventImpl
<<Enum>>
EventType
(edu::ksu::cis::macr::goal::model::testdriver::GoalEvent)
<<Constant>> -ACHIEVED
<<Constant>> -FAILED
<<Constant>> -POSITIVE_TRIGGER
<<Constant>> -NEGATIVE_TRIGGER
<<Constant>> -MODIFIED
<<Interface>>
TestDriver
(edu::ksu::cis::macr::goal::model::visualizer)
+addObserver(o : Observer) : void
+loadEventScript(eventScript : File) : void
+saveEventScript(eventScript : File) : void
+issueRandomEvents() : void
+play() : void
+pause() : void
+next() : void
+hasNext() : boolean
<<Interface>>
GoalEvent
+getType() : EventType
+getSpecificationGoalIdentifier() : UniqueIdentifier
+getInstanceGoalIdentifier() : UniqueIdentifier
+getEventIdentifier() : UniqueIdentifier
+issueToGMoDS(gmods : GoalTree) : void
+getParameters() : Map<UniqueIdentifier, Object>
+getDelayTime() : int
-event
*
<<Interface>>
GoalTree
(edu::ksu::cis::macr::goal::model)
#gmods
1
Events
EventScriptImpl
GMoDSTestDriverImpl
1
driver
script
1
Script
<<Interface>>
EventScript
+play() : void
+pause() : void
+next() : void
+hasNext() : boolean
+addObserver(o : Observer) : void
+addEvent(e : GoalEvent) : void
+writeXML() : String
+isPlaying() : boolean
+issueNotificationToObservers() : void

Figure 37 GMoDS Test Driver Architecture

Figure 37 above shows the GMoDS Test Driver architecture described in detail in 4.3.1. Figure 38 below shows the component classes that implement random events for the GMoDS Test Driver.

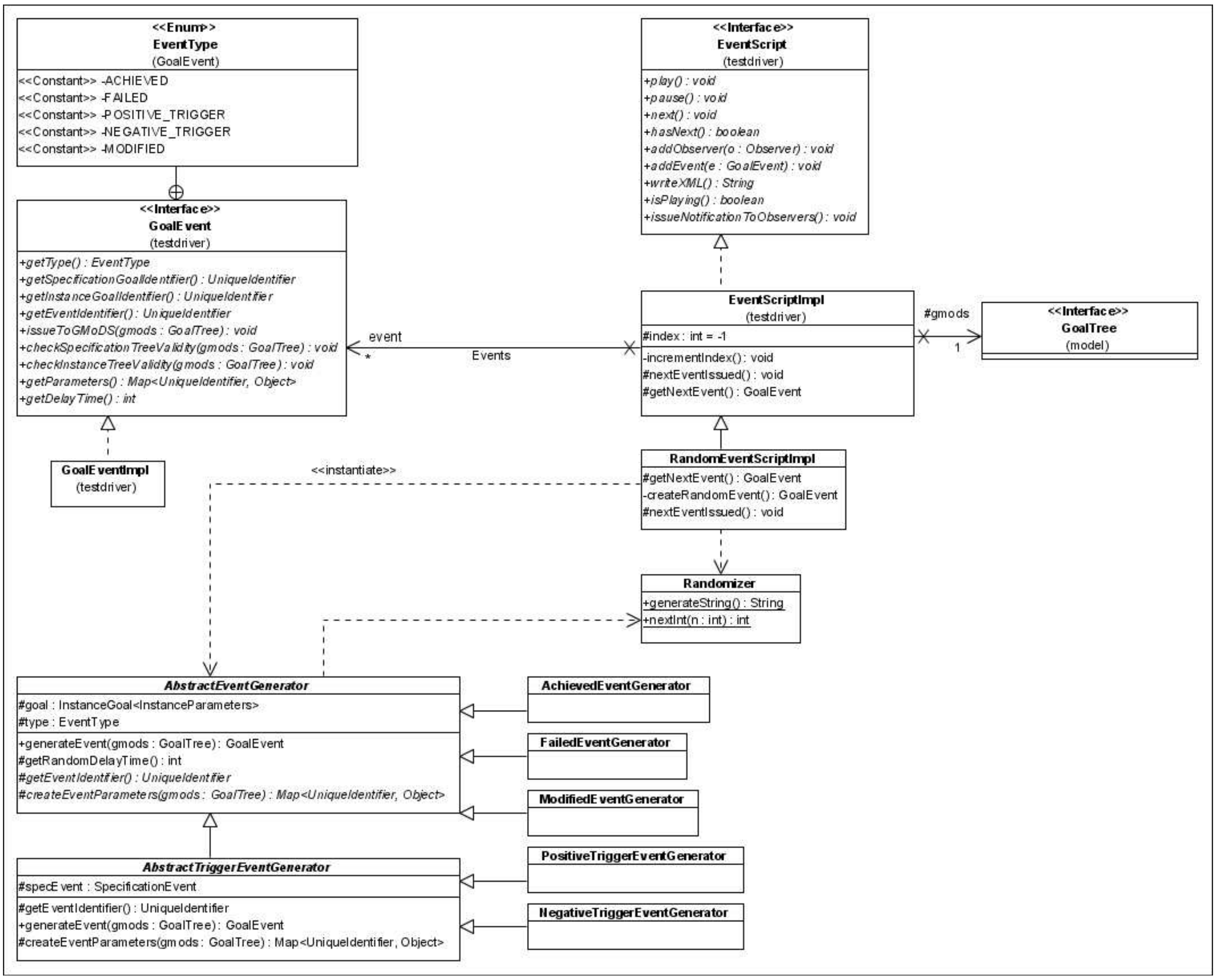

<<Enum>>
EventType
(GoalEvent)
<<Constant>> -ACHIEVED
<<Constant>> -FAILED
<<Constant>> -POSITIVE_TRIGGER
<<Constant>> -NEGATIVE_TRIGGER
<<Constant>> -MODIFIED
<<Interface>>
GoalEvent
(testdriver)
+getType() : EventType
+getSpecificationGoalIdentifier() : UniqueIdentifier
+getInstanceGoalIdentifier() : UniqueIdentifier
+getEventIdentifier() : UniqueIdentifier
+issueToGMoDS(gmods : GoalTree) : void
+checkSpecificationTreeValidity(gmods : GoalTree) : void
+checkInstanceTreeValidity(gmods : GoalTree) : void
+getParameters() : Map<UniqueIdentifier, Object>
+getDelayTime() : int
GoalEventImpl
(testdriver)
<<Interface>>
EventScript
(testdriver)
+play() : void
+pause() : void
+next() : void
+hasNext() : boolean
+addObserver(o : Observer) : void
+addEvent(e : GoalEvent) : void
+writeXML() : String
+isPlaying() : boolean
+issueNotificationToObservers() : void
EventScriptImpl
(testdriver)
#index : int = -1
-incrementIndex() : void
#nextEventIssued() : void
#getNextEvent() : GoalEvent
event
*
Events
#gmods
1
<<Interface>>
GoalTree
(model)
RandomEventScriptImpl
#getNextEvent() : GoalEvent
-createRandomEvent() : GoalEvent
#nextEventIssued() : void
<<instantiate>>
Randomizer
+generateString() : String
+nextInt(n : int) : int
AbstractEventGenerator
#goal : InstanceGoal<InstanceParameters>
#type : EventType
+generateEvent(gmods : GoalTree) : GoalEvent
#getRandomDelayTime() : int
#getEventIdentifier() : UniqueIdentifier
#createEventParameters(gmods : GoalTree) : Map<UniqueIdentifier, Object>
AbstractTriggerEventGenerator
#specEvent : SpecificationEvent
#getEventIdentifier() : UniqueIdentifier
+generateEvent(gmods : GoalTree) : GoalEvent
#createEventParameters(gmods : GoalTree) : Map<UniqueIdentifier, Object>
AchievedEventGenerator
FailedEventGenerator
ModifiedEventGenerator
PositiveTriggerEventGenerator
NegativeTriggerEventGenerator

Figure 38 GMoDS Test Driver Random Events Component Classes

7.2.1.1.1 GMoDS Test Driver Local Module Responsibilities

This section describes the responsibilities of GMoDS Test Driver local modules (not described in 4.3.2).

Table 28 GMoDS Test Driver Module Responsibilities

Component	Responsibilities
AbstractEventGenerator	Define the behaviors required to generate a random GoalEvent.
AbstractTriggerEventGenerator	Define the behaviors of a trigger-based GoalEvent.
AchievedEventGenerator	Generate a random ACHIEVED GoalEvent.
FailedEventGenerator	Generate a random FAILED GoalEvent.
ModifiedEventGenerator	Generate a random MODIFIED GoalEvent.

Component	Responsibilities
PositiveTriggerEventGenerator	Generate a random POSITIVE_TRIGGER GoalEvent.
NegativeTriggerEventGenerator	Generate a random NEGATIVE_TRIGGER GoalEvent.
Randomizer	Provide random number and string utilities.

7.2.1.1.2 GMoDS Test Driver Local Module Interface Specifications

Table 29 AbstractEventGenerator Interface Specifications

Generate a random GoalEvent.	Syntax:	generateEvent(gmods : GoalTree) : GoalEvent
	Pre:	gmods != null
	Pre:	GoalEvent that can be generated by this generator is applicable to the current state of GMoDS.
	Post:	Result = new random GoalEvent of the type represented by this generator.
Generate a random event delay time.	Syntax:	getRandomDelayTime() : int
	Pre:	none
	Post:	Result = new random integer in the range defined by the GMoDS Visualizer's RandomEventParameters.
Get the identifier of the random event known to GMoDS.	Syntax:	getEventIdentifier() : UniqueIdentifier
	Pre:	none
	Post:	Result = the UniqueIdentifier of the generated GoalEvent that identifies it to GMoDS.
Create random event parameters if applicable.	Syntax:	createEventParameters(gmods : GoalTree) : Map<UniqueIdentifier, Object>
	Pre:	none
	Post:	Result = a new Map<UniqueIdentifier, Object> containing the applicable parameter names and their random values.

7.2.1.1.3 GMoDS Test Driver Design Rationale

I chose event generators to compactly represent each potential GoalEvent available in the current state of GMoDS, delaying expansion until after the potential event is randomly selected. This increases the efficiency of incremental event generation.

7.2.1.2 GMoDS Test Driver Behavior

Figure 39 below shows the EventScriptImpl.addEvent method. Each GoalEvent added to the script must first pass all validity checks with respect to the specification tree. If an event fails, an IllegalGoalEventException is thrown, logged, and presented to the user; the event is not added. If the event passes the validity checks, it is added to the script and all observers of notified of the change.

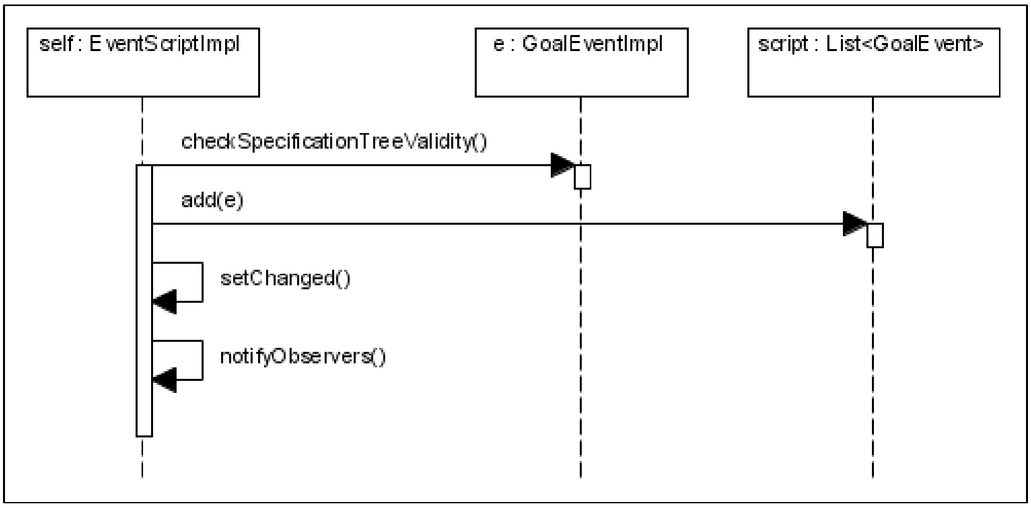


Figure 39 EventScriptImpl.addEvent(GoalEvent e)

Figure 40 below shows the EventScriptImpl.next method. The default implementation of getNextEvent() provides deterministic event script operation simply selecting the next event in the file. RandomEventScriptImpl overrides getNextEvent() to incrementally create the next random event. The incrementIndex() method moves the event pointer to the following event. The next event checks its validity with respect to GMoDS’ instance tree. If an event fails, an IllegalGoalEventException is thrown, logged, and presented to the user; the event is not issued to GMoDS. If the event passes the validity checks, it is issued to GMoDS. The script then notifies itself that it has issued the next event. This is a hook for the RandomEventScriptImpl to override to prepare to create the next random event. Finally, script notifies observers of the change in its state.

Figure 41 below shows the RandomEventScriptImpl.getNextEvent method. This method refers to a data member called “nextEvent” used to hold onto the GoalEvent currently being issued to GMoDS, so that it can be added to the script in “nextEventIssued()” after is passes validity checks and is issued.   This allows the script to grow incrementally and be saved to a file. The next event can be created randomly if the “nextEvent” data member has been set to null by “nextEventIssued()”.

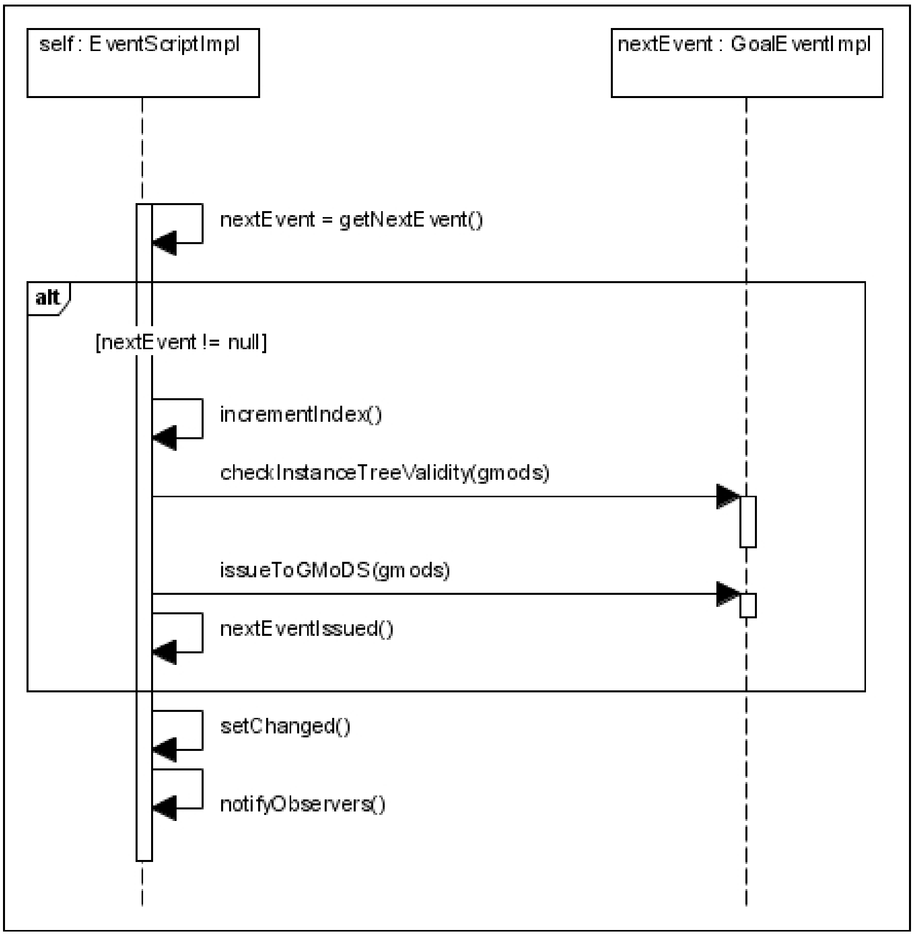


Figure 40 EventScriptImpl.next()

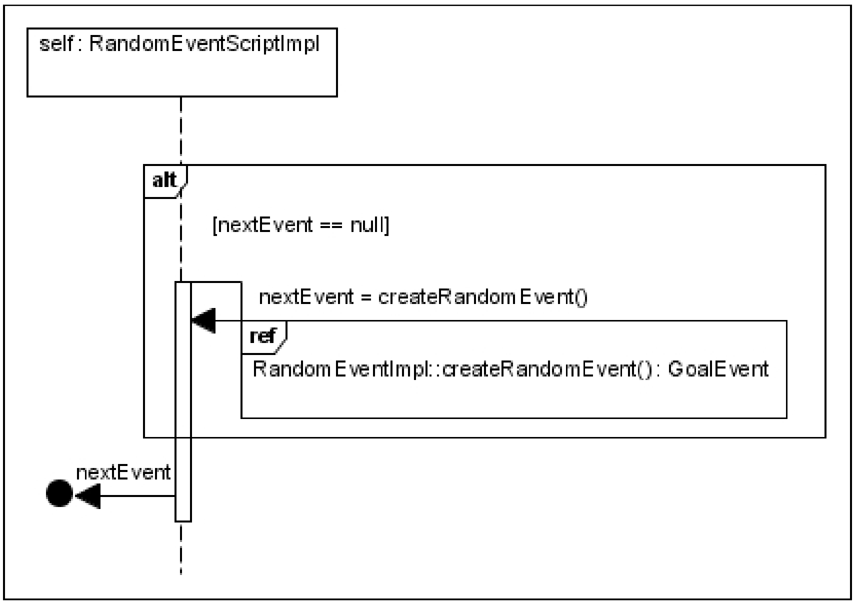

self : RandomEventScriptImpl
alt
[nextEvent == null]
nextEvent = createRandomEvent()
ref
RandomEventImpl::createRandomEvent() : GoalEvent
nextEvent

Figure 41 RandomEventScriptImpl.getNextEvent()

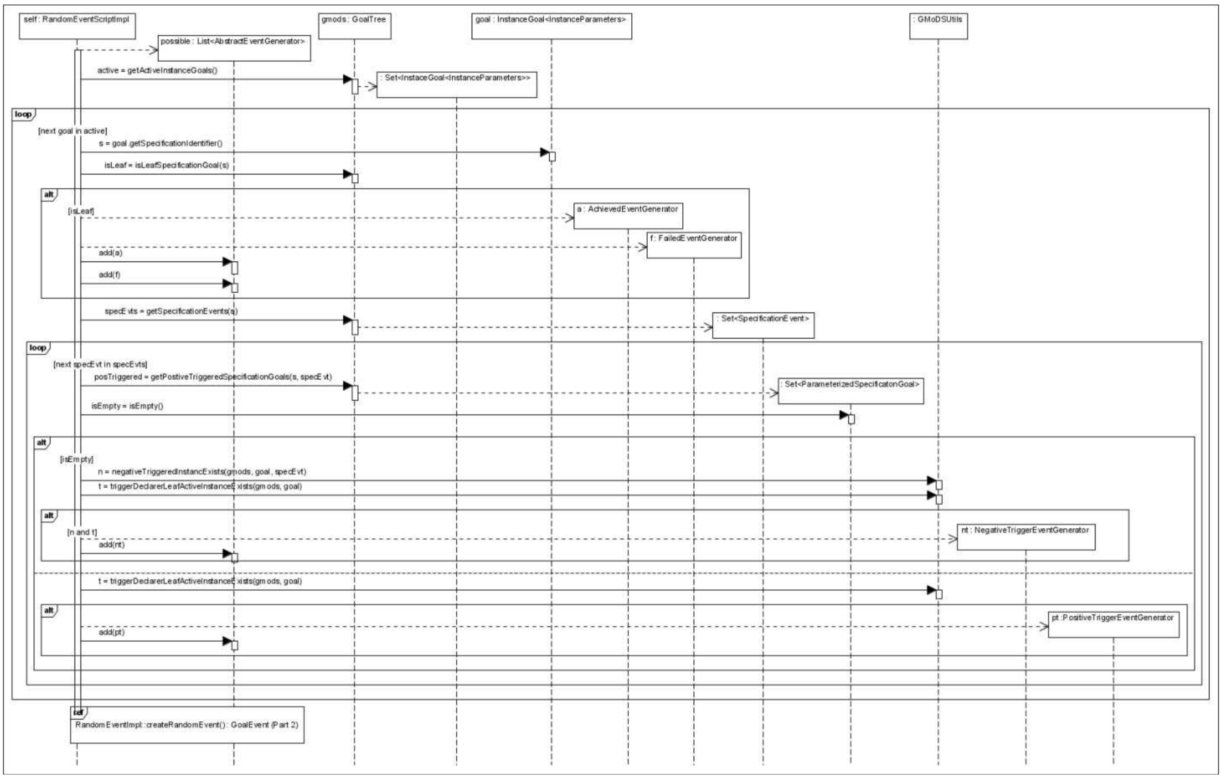

self : RandomEventScriptImpl
possible : List<AbstractEventGenerator>
gmods : GoalTree
goal : InstanceGoal<InstanceParameters>
: GMoDSUtils
active = getActiveInstanceGoals()
: Set<InstaceGoal<InstanceParameters>>
loop
[next goal in active]
s = goal.getSpecificationIdentifier()
isLeaf = isLeafSpecificationGoal(s)
alt
[isLeaf]
a : AchievedEventGenerator
f : FailedEventGenerator
add(a)
add(f)
specEvts = getSpecificationEvents(s)
: Set<SpecificationEvent>
loop
[next specEvt in specEvts]
posTriggered = getPostiveTriggeredSpecificationGoals(s, specEvt)
: Set<ParameterizedSpecificatonGoal>
isEmpty = isEmpty()
alt
[isEmpty]
n = negativeTriggeredInstanceExists(gmods, goal, specEvt)
t = triggerDeclarerLeafActiveInstanceExists(gmods, goal)
alt
[n and t]
nt : NegativeTriggerEventGenerator
add(nt)
t = triggerDeclarerLeafActiveInstanceExists(gmods, goal)
alt
pt : PositiveTriggerEventGenerator
add(pt)
ref
RandomEventImpl::createRandomEvent() : GoalEvent (Part 2)

Figure 42 RandomEventScript.createRandomEvent() : GoalEvent (Part 1)

Figure 42 above shows the first half of the process of creating a random GoalEvent. Every active leaf instance goal may be ACHIEVED or FAILED so event generators of these types are added to the list “possible”. Then every specification event of each active goal is obtained from GMoDS. The method loops on each specification event and determines whether it defines a positive trigger or a negative trigger.

If it is a negative trigger, an instance goal pointed to by the negative trigger must exist and an instance of a leaf specification goal descended from the specification goal that declared the trigger must exist. If these conditions are met, a NegativeTriggerGenerator is added to “possible” representing the specification event.

If it is a positive trigger, an instance of a leaf specification goal descended from the specification goal that declared the trigger must exist. If this condition is met, a PositiveTriggerGenerator is added to “possible” representing the specification event.

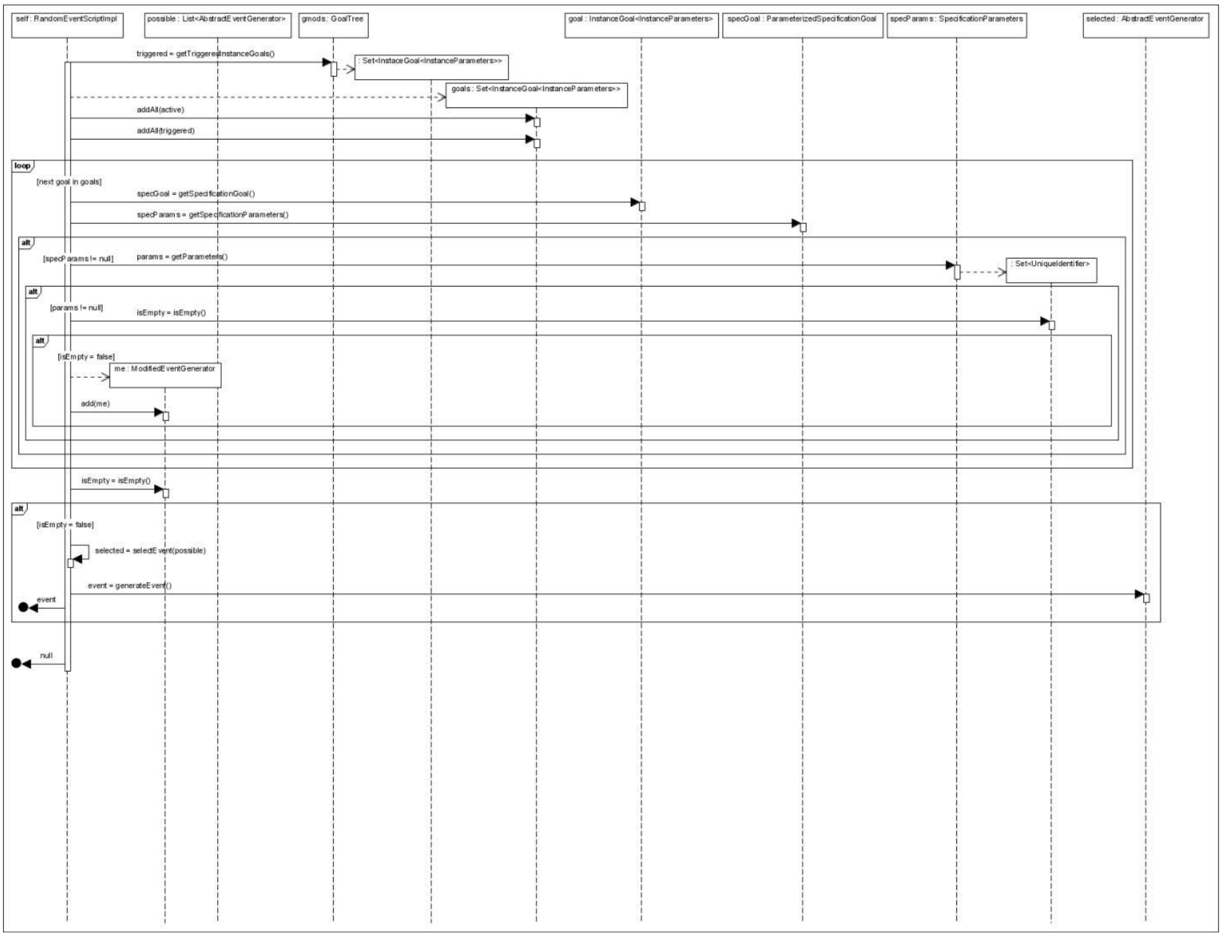

self : RandomEventScriptImpl
possible : List<AbstractEventGenerator>
gmods : GoalTree
goal : InstanceGoal<InstanceParameters>
specGoal : ParameterizedSpecificationGoal
specParams : SpecificationParameters
selected : AbstractEventGenerator
triggered = getTriggeredInstanceGoals()
: Set<InstaceGoal<InstanceParameters>>
goals : Set<InstanceGoal<InstanceParameters>>
addAll(active)
addAll(triggered)
loop
[next goal in goals]
specGoal = getSpecificationGoal()
specParams = getSpecificationParameters()
alt
[specParams != null]
params = getParameters()
: Set<UniqueIdentifier>
alt
[params != null]
isEmpty = isEmpty()
alt
[isEmpty = false]
me : ModifiedEventGenerator
add(me)
isEmpty = isEmpty()
alt
[isEmpty = false]
selected = selectEvent(possible)
event = generateEvent()
event
null

Figure 43 RandomEventScriptImpl.createRandomEvent() : GoalEvent (Part 2)

Figure 43 above shows the second half of the process of creating a random GoalEvent. All triggered and active instance goals may be modified if their specification goal defines parameters. If so, a ModifiedEventGenerator is added to “possible”. If there is at least one possible GoalEvent, an AbstractsEventGenerator is randomly selected from “possible” and it generates a random GoalEvent which is returned.

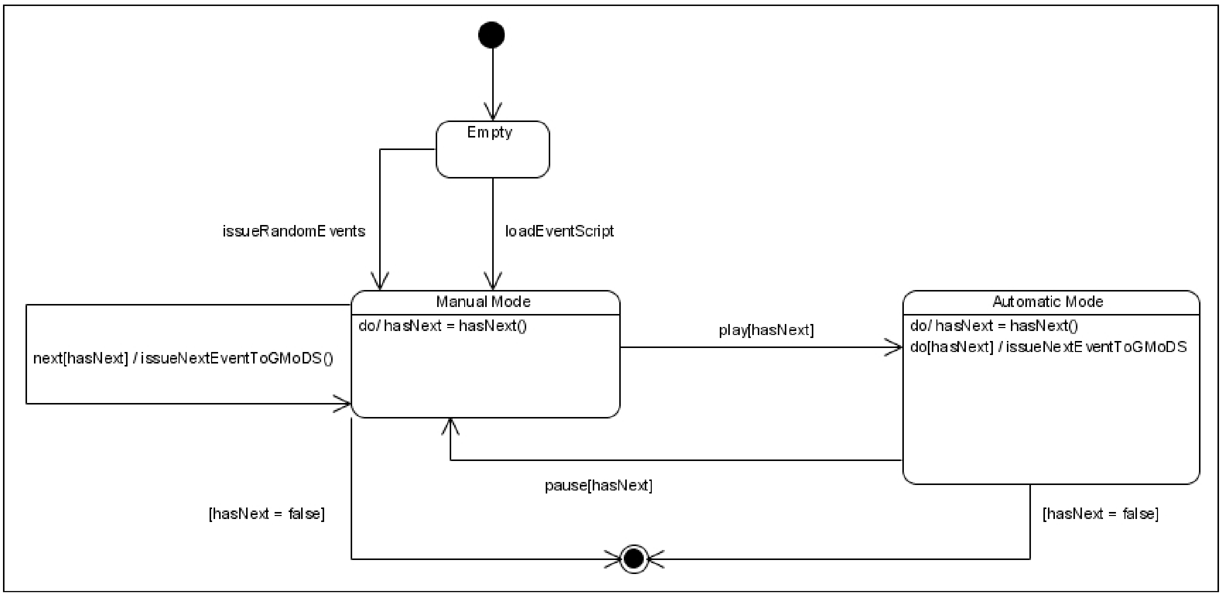


Figure 44 GMoDS Test Driver UI Controls State Diagram

Figure 44 above shows the states of the GMoDS Test Driver in response to the toolbar buttons and menu items that control it.   This diagram suppresses differences between random and file-based events (incremental event generation versus a complete script load). The Test Driver starts with an empty script. If the user selects “load event script” or “issue random events” the Test Driver moves to Manual Mode. Clicking next issues the next event to GMoDS if valid and returns to Manual Mode if there is a next event possible. Clicking play while in Manual Mode moves the Test Driver to Automatic Mode if there is a next event possible. Clicking pause while in Automatic Mode moves the Test Driver to Manual Mode if there is a next event possible. In either Manual or Automatic Mode if there is not an event possible the Test Driver is finished.

7.2.2 GMoDS Visualizer Component Design

The GMoDS Visualizer uses the Model-View-Controller architecture. This section shows the detailed component design in separate sections for the model, view, and controller portions of the architecture.

7.2.2.1 GMoDS Visualizer Model Static Structure

Figure 45 below shows the “model” portion of the GMoDS Visualizer architecture to show how GMoDS is referenced.

Figure 46 below shows the detailed component classes of the “model”.

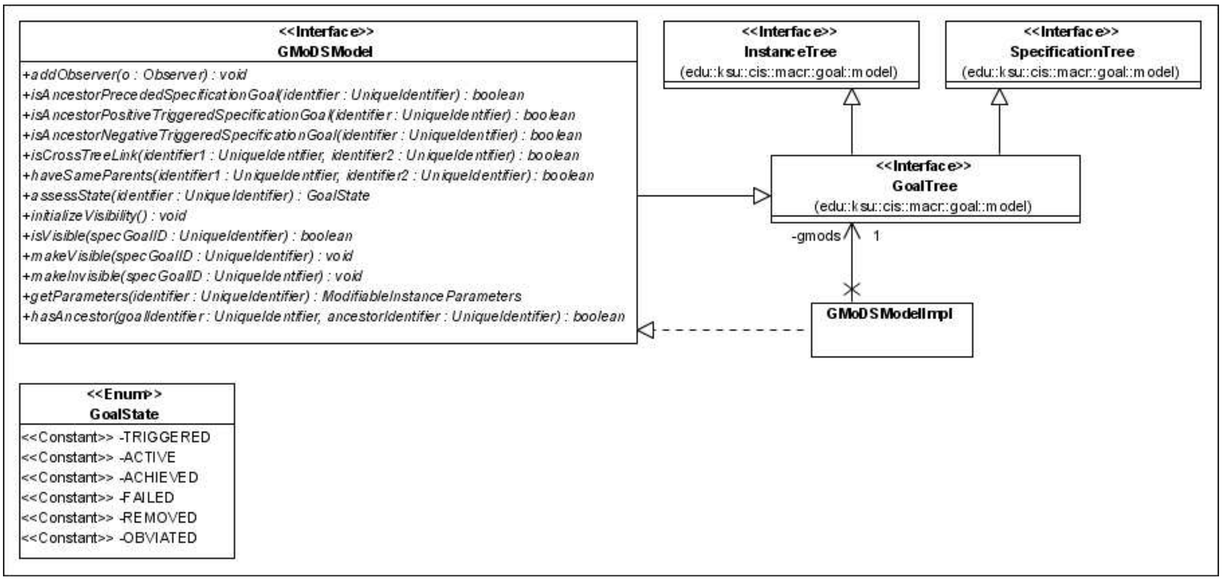

<<Interface>>
GMoDSModel
+addObserver(o : Observer) : void
+isAncestorPrecededSpecificationGoal(identifier : UniqueIdentifier) : boolean
+isAncestorPositiveTriggeredSpecificationGoal(identifier : UniqueIdentifier) : boolean
+isAncestorNegativeTriggeredSpecificationGoal(identifier : UniqueIdentifier) : boolean
+isCrossTreeLink(identifier1 : UniqueIdentifier, identifier2 : UniqueIdentifier) : boolean
+haveSameParents(identifier1 : UniqueIdentifier, identifier2 : UniqueIdentifier) : boolean
+assessState(identifier : UniqueIdentifier) : GoalState
+initializeVisibility() : void
+isVisible(specGoalID : UniqueIdentifier) : boolean
+makeVisible(specGoalID : UniqueIdentifier) : void
+makeInvisible(specGoalID : UniqueIdentifier) : void
+getParameters(identifier : UniqueIdentifier) : ModifiableInstanceParameters
+hasAncestor(goalIdentifier : UniqueIdentifier, ancestorIdentifier : UniqueIdentifier) : boolean
<<Interface>>
InstanceTree
(edu::ksu::cis::macr::goal::model)
<<Interface>>
SpecificationTree
(edu::ksu::cis::macr::goal::model)
<<Interface>>
GoalTree
(edu::ksu::cis::macr::goal::model)
-gmods
1
GMoDSModelImpl
<<Enum>>
GoalState
<<Constant>> -TRIGGERED
<<Constant>> -ACTIVE
<<Constant>> -ACHIEVED
<<Constant>> -FAILED
<<Constant>> -REMOVED
<<Constant>> -OBVIATED

Figure 45 GMoDS Visualizer Model Architecture

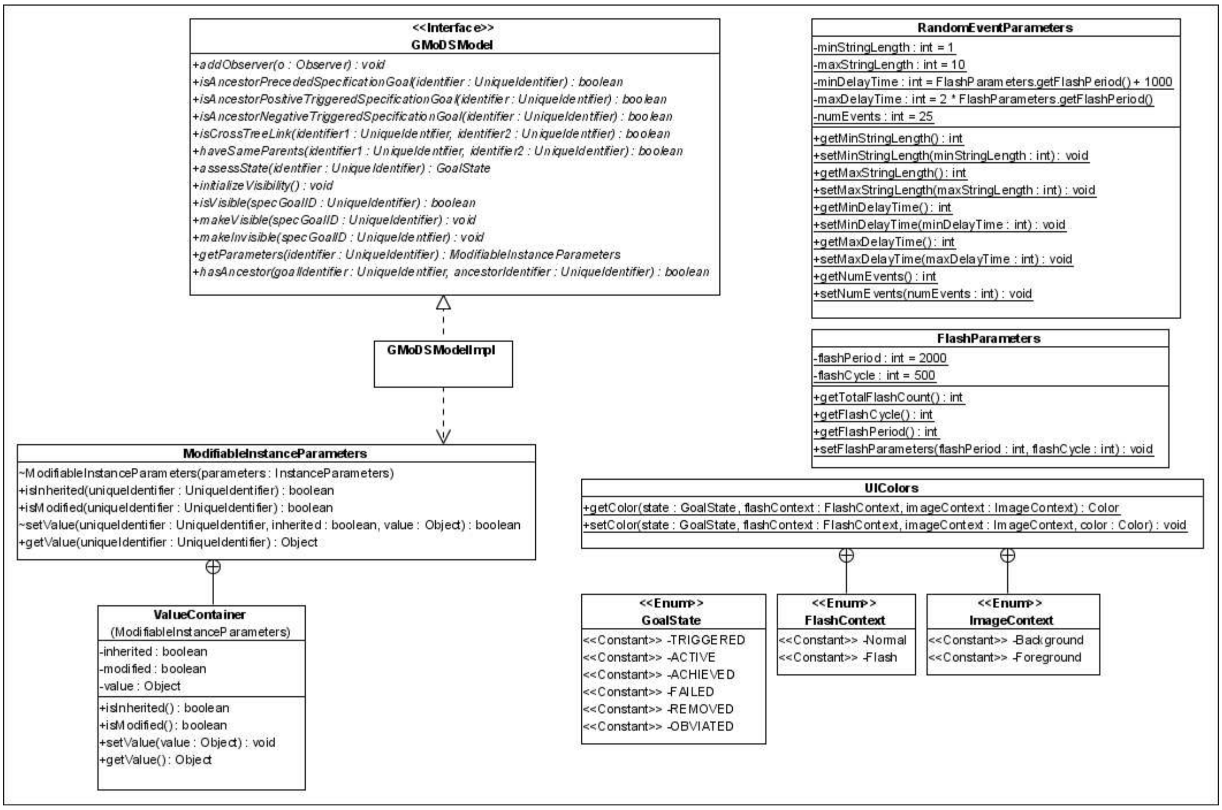

<<Interface>>
GMoDSModel
+addObserver(o : Observer) : void
+isAncestorPrecededSpecificationGoal(identifier : UniqueIdentifier) : boolean
+isAncestorPositiveTriggeredSpecificationGoal(identifier : UniqueIdentifier) : boolean
+isAncestorNegativeTriggeredSpecificationGoal(identifier : UniqueIdentifier) : boolean
+isCrossTreeLink(identifier1 : UniqueIdentifier, identifier2 : UniqueIdentifier) : boolean
+haveSameParents(identifier1 : UniqueIdentifier, identifier2 : UniqueIdentifier) : boolean
+assessState(identifier : UniqueIdentifier) : GoalState
+initializeVisibility() : void
+isVisible(specGoalID : UniqueIdentifier) : boolean
+makeVisible(specGoalID : UniqueIdentifier) : void
+makeInvisible(specGoalID : UniqueIdentifier) : void
+getParameters(identifier : UniqueIdentifier) : ModifiableInstanceParameters
+hasAncestor(goalIdentifier : UniqueIdentifier, ancestorIdentifier : UniqueIdentifier) : boolean
RandomEventParameters
-minStringLength : int = 1
-maxStringLength : int = 10
-minDelayTime : int = FlashParameters.getFlashPeriod() + 1000
-maxDelayTime : int = 2 * FlashParameters.getFlashPeriod()
-numEvents : int = 25
+getMinStringLength() : int
+setMinStringLength(minStringLength : int) : void
+getMaxStringLength() : int
+setMaxStringLength(maxStringLength : int) : void
+getMinDelayTime() : int
+setMinDelayTime(minDelayTime : int) : void
+getMaxDelayTime() : int
+setMaxDelayTime(maxDelayTime : int) : void
+getNumEvents() : int
+setNumEvents(numEvents : int) : void
GMoDSModelImpl
FlashParameters
-flashPeriod : int = 2000
-flashCycle : int = 500
+getTotalFlashCount() : int
+getFlashCycle() : int
+getFlashPeriod() : int
+setFlashParameters(flashPeriod : int, flashCycle : int) : void
ModifiableInstanceParameters
~ModifiableInstanceParameters(parameters : InstanceParameters)
+isInherited(uniqueIdentifier : UniqueIdentifier) : boolean
+isModified(uniqueIdentifier : UniqueIdentifier) : boolean
~setValue(uniqueIdentifier : UniqueIdentifier, inherited : boolean, value : Object) : boolean
+getValue(uniqueIdentifier : UniqueIdentifier) : Object
UIColors
+getColor(state : GoalState, flashContext : FlashContext, imageContext : ImageContext) : Color
+setColor(state : GoalState, flashContext : FlashContext, imageContext : ImageContext, color : Color) : void
ValueContainer
(ModifiableInstanceParameters)
-inherited : boolean
-modified : boolean
-value : Object
+isInherited() : boolean
+isModified() : boolean
+setValue(value : Object) : void
+getValue() : Object
<<Enum>>
GoalState
<<Constant>> -TRIGGERED
<<Constant>> -ACTIVE
<<Constant>> -ACHIEVED
<<Constant>> -FAILED
<<Constant>> -REMOVED
<<Constant>> -OBVIATED
<<Enum>>
FlashContext
<<Constant>> -Normal
<<Constant>> -Flash
<<Enum>>
ImageContext
<<Constant>> -Background
<<Constant>> -Foreground

Figure 46 GMoDS Visualizer Model Component Classes

7.2.2.1.1 GMoDS Visualizer Model Local Module Responsibilities

Table 30 GMoDS Visualizer Model Module Responsibilities

Component	Responsibilities
ModifiableInstanceParameters	Record the current value of each InstanceGoal parameter so that if the value changes it can be ascribed the parameter value origin “MODIFICATION”.
ValueContainer	Record the current value of a particular InstanceGoal parameter.
RandomEventParameters	Define the parameters guiding random event generation.
FlashParameters	Define the parameters guiding InstanceGoalUI flashing.
UIColors	Define the colors used when drawing an InstanceGoalUI for the combination of GoalState, FlashContext, and ImageContext.
GoalState	Enumerate the possible goal states.
FlashContext	Enumerate the possible states of a flash.
ImageContext	Enumerate the portions of an image requiring colors.

7.2.2.1.2 GMoDS Visualizer Model Local Module Interface Specifications

Table 31 ModifiableInstanceParameters Interface Specifications

Query the inherited property of a specific parameter.	Syntax:	isInherited(uniqueIdentifier : UniqueIdentifier) : boolean
	Pre:	uniqueIdentifier != null
	Post:	Result = true if the specified parameter’s value is inherited.
Query the modified property of a specific parameter.	Syntax:	isModified(uniqueIdentifier : UniqueIdentifier) : boolean
	Pre:	uniqueIdentifier != null
	Post:	Result = true if the specified parameter’s value has changed.

Set the value of a specific parameter.	Syntax:	setValue(uniqueIdentifier : UniqueIdentifier, inherited : boolean, value : Object) : boolean
	Pre:	uniqueIdentifier != null
	Pre:	value != null
	Post:	Result = true if the specified parameter’s value has changed.
Get the value of a specific parameter.	Syntax:	getValue(uniqueIdentifier : UniqueIdentifier) : Object
	Pre:	uniqueIdentifier != null
	Post:	Result = the value of the parameter.

Table 32 ValueContainer Interface Specifications

Query the inherited property of a specific parameter.	Syntax:	isInherited() : boolean
	Post:	Result = true if the specified parameter’s value is inherited.
Query the modified property of a specific parameter.	Syntax:	isModified() : boolean
	Post:	Result = true if the specified parameter’s value has changed.
Set the value of a specific parameter.	Syntax:	setValue(value : Object) : boolean
	Pre:	value != null
	Post:	Result = true if the specified parameter’s value has changed.
Get the value of a specific parameter.	Syntax:	getValue() : Object
	Post:	Result = the value of the parameter.

Table 33 RandomEventParameters Interface Specification

Query the minimum string length for a random parameter value.	Syntax:	getMinStringLength() : int
	Post:	Result = the minimum string length for a parameter value.

Set the minimum string length for a random parameter value.	Syntax:	setMinStringLength(minStringLength : int) : void
	Post:	Record the minimum string length for a random parameter value.
Query the maximum string length for a random parameter value.	Syntax:	getMaxStringLength() : int
	Post:	Result = the maximum string length for a parameter value.
Set the maximum string length for a random parameter value.	Syntax:	setMaxStringLength(maxStringLength : int) : void
	Post:	Record the maximum string length for a random parameter value.
Query the minimum delay time for a random event.	Syntax:	getMinDelayTime() : int
	Post:	Result = the minimum delay time for a random event.
Set the minimum delay time for a random event.	Syntax:	setMinDelayTime (minDelayTime : int) : void
	Post:	Record the minimum delay time for a random event.
Query the maximum delay time for a random event.	Syntax:	getMaxDelayTime () : int
	Post:	Result = the maximum delay time for a random event.
Set the maximum delay time for a random event.	Syntax:	setMaxDelayTime (maxDelayTime : int) : void
	Post:	Record the maximum delay time for a random event.
Query the maximum number of random events.	Syntax:	getNumEvents () : int
	Post:	Result = the maximum number of random events.
Set the maximum number of random events.	Syntax:	setNumEvents (numEvents : int) : void
	Post:	Record the maximum number of random events.

Table 34 FlashParameters Interface Specification

Query the total number of times an InstanceGoalUI should flash.	Syntax:	getTotalFlashCount() : int
	Post:	Result = the total number of times an InstanceGoalUI should flash.

Query the number of milliseconds in a cycle of flash and normal display.	Syntax:	getFlashCycle() : int
	Post:	Result = the number of milliseconds in a cycle of flash and normal display.
Query the total number of milliseconds of flashing desired.	Syntax:	getFlashPeriod() : int
	Post:	Result = the total number of milliseconds of flashing desired.
Update the flash parameters with consistent values.	Syntax:	setFlashParameters(flashPeriod : int, flashCycle : int) : void
	Post:	Record values of the flash parameters consistent with each other.

Table 35 UIColors Interface Specification

Query the color of an InstanceGoalUI for the combination of GoalState, FlashContext, and ImageContext.	Syntax:	getColor(state : GoalState, flashContext : FlashContext, imageContext : ImageContext) : Color
	Post:	Result = the color of an InstanceGoalUI for the combination of GoalState, FlashContext, and ImageContext.
Set the color of an InstanceGoalUI for the combination of GoalState, FlashContext, and ImageContext.	Syntax:	setColor(state : GoalState, flashContext : FlashContext, imageContext : ImageContext, color : Color) : void
	Post:	Record the color of an InstanceGoalUI for the combination of GoalState, FlashContext, and ImageContext.

7.2.2.1.3 GMoDS Visualizer Model Design Rationale

I designed ModifiableInstanceParameters starting with GMoDS' InstanceParameters class to make it easy to incorporate support for the "MODIFICATION" parameter value origin directly into GMoDS, if desired.

7.2.2.2 GMoDS Visualizer Model Behavior

Figure 47 below shows the GMoDSModelImpl.notifyInstanceGoalModified method of the ChangeManager interface. This method records the new values of the instance parameters to add support for the "MODIFICATION" parameter value origin by calling the updateInstanceGoal method (see Figure 48). It then notifies observers that the model has changed. The observer initiates flashing of the affected InstanceGoalUI. The notifyInstanceGoalModified method is an example of how all the other instance tree-related ChangeManager methods notify the observers.

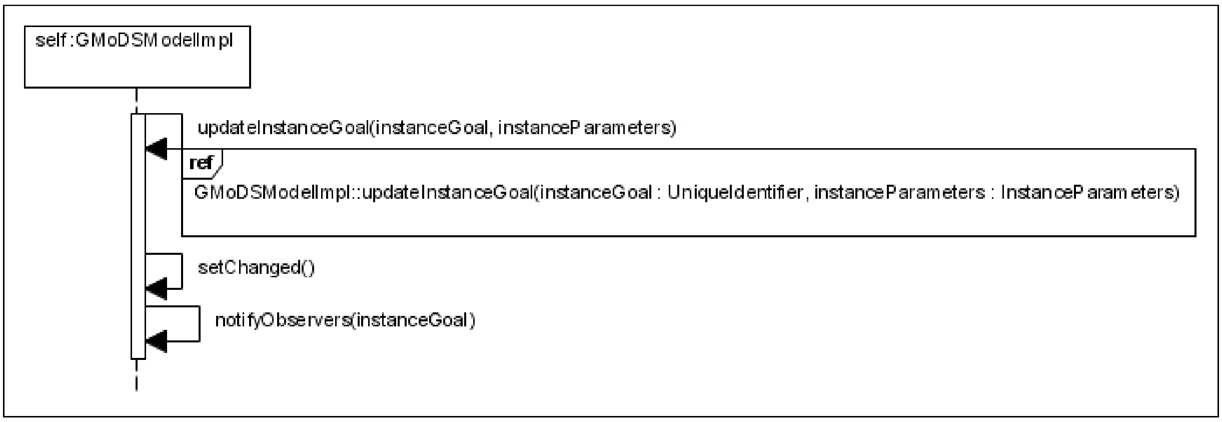

self :GMoDSModelImpl
updateInstanceGoal(instanceGoal, instanceParameters)
ref
GMoDSModelImpl::updateInstanceGoal(instanceGoal : UniqueIdentifier, instanceParameters : InstanceParameters)
setChanged()
notifyObservers(instanceGoal)

Figure 47 GMoDSModelImpl.notifyInstanceGoalModified(instanceGoal : UniqueIdentifier, instanceParameters : InstanceParameters)

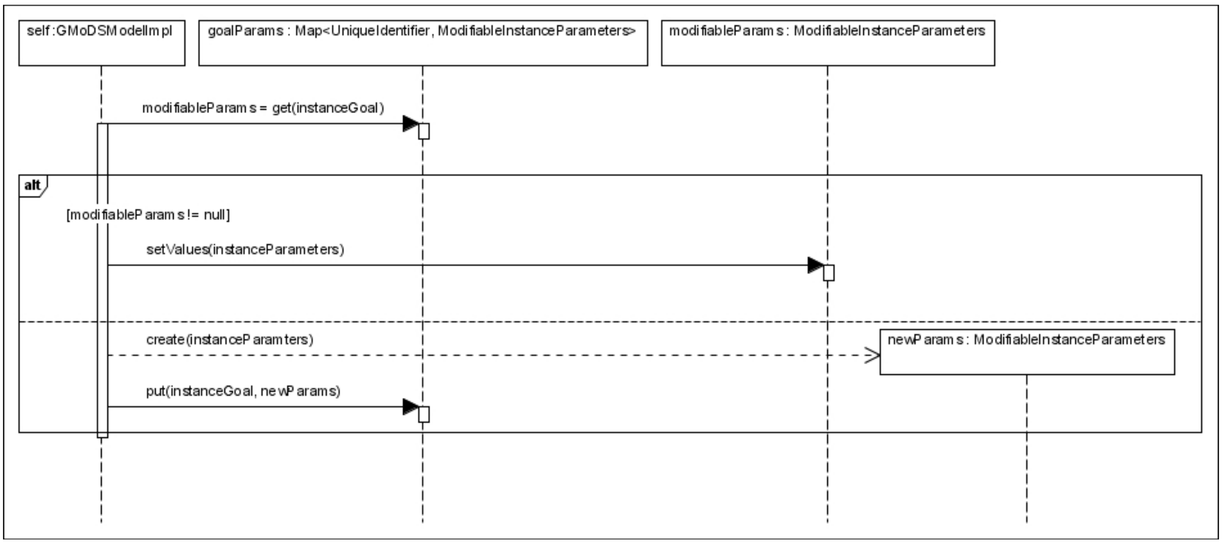

self :GMoDSModelImpl
goalParams : Map<UniqueIdentifier, ModifiableInstanceParameters>
modifiableParams : ModifiableInstanceParameters
modifiableParams = get(instanceGoal)
alt
[modifiableParams != null]
setValues(instanceParameters)
create(instanceParamters)
newParams : ModifiableInstanceParameters
put(instanceGoal, newParams)

Figure 48 GMoDSModelImpl.updateInstanceGoal(instanceGoal : UniqueIdentifier, instanceParameters : InstanceParameters)

7.2.2.3 GMoDS Visualizer View Static Structure

Figure 49 below shows the architecture of the GMoDS Visualizer view package described in detail in 4.4.5. The EditPreferenceUI has been added as a new view not shown in the component class diagrams focused on the specification and instance tree views below.

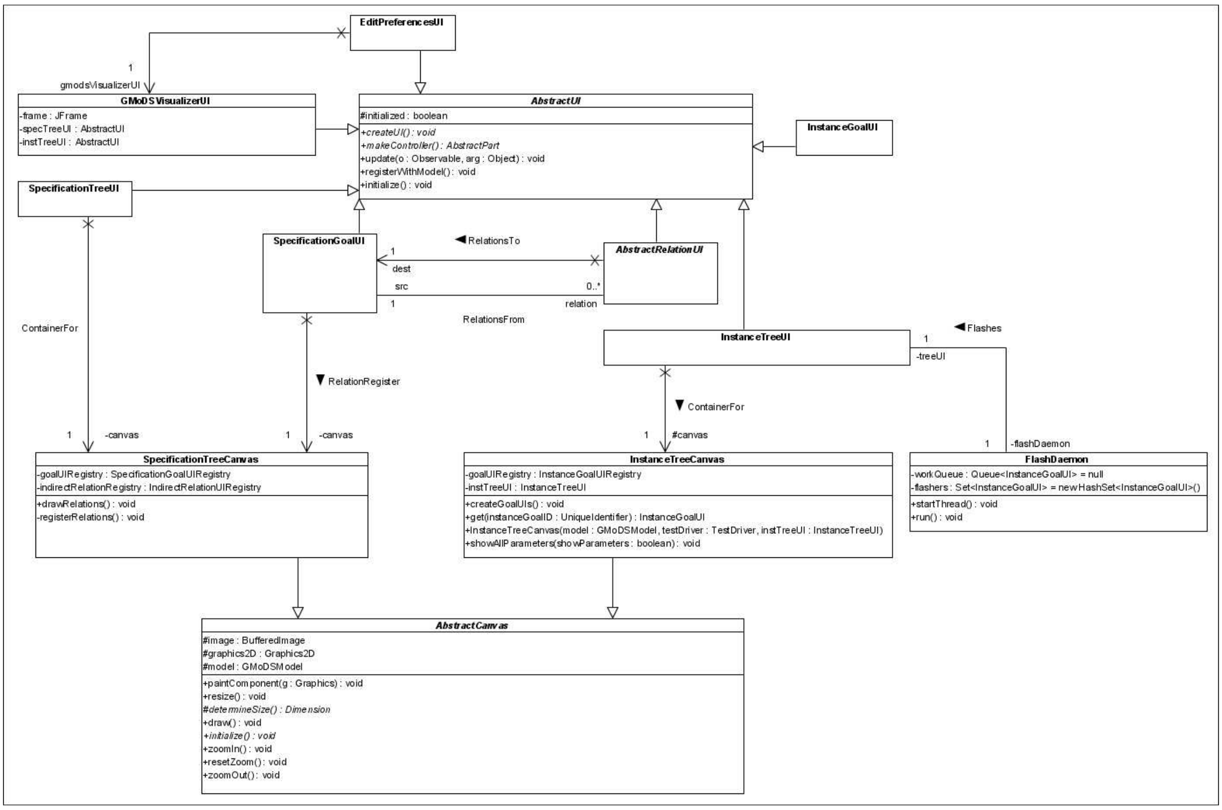


Figure 49 GMoDS Visualizer View Architecture

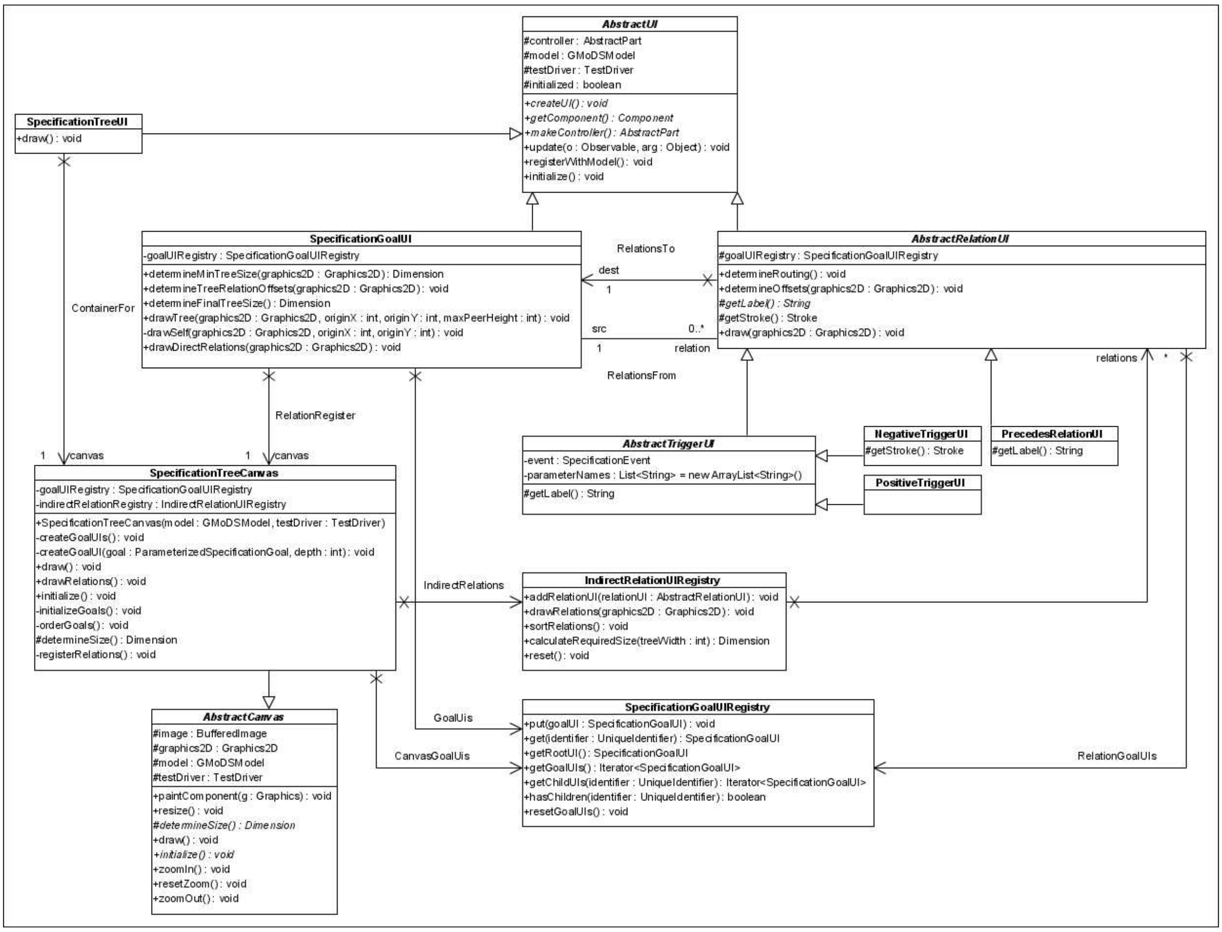

AbstractUI
#controller : AbstractPart
#model : GMoDSModel
#testDriver : TestDriver
#initialized : boolean
+createUI() : void
+getComponent() : Component
+makeController() : AbstractPart
+update(o : Observable, arg : Object) : void
+registerWithModel() : void
+initialize() : void
SpecificationTreeUI
+draw() : void
ContainerFor
SpecificationGoalUI
-goalUIRegistry : SpecificationGoalUIRegistry
+determineMinTreeSize(graphics2D : Graphics2D) : Dimension
+determineTreeRelationOffsets(graphics2D : Graphics2D) : void
+determineFinalTreeSize() : Dimension
+drawTree(graphics2D : Graphics2D, originX : int, originY : int, maxPeerHeight : int) : void
-drawSelf(graphics2D : Graphics2D, originX : int, originY : int) : void
+drawDirectRelations(graphics2D : Graphics2D) : void
RelationsTo
dest
1
src
0..*
1
relation
RelationsFrom
AbstractRelationUI
#goalUIRegistry : SpecificationGoalUIRegistry
+determineRouting() : void
+determineOffsets(graphics2D : Graphics2D) : void
#getLabel() : String
#getStroke() : Stroke
+draw(graphics2D : Graphics2D) : void
relations
*
RelationRegister
1
/canvas
1
/canvas
SpecificationTreeCanvas
-goalUIRegistry : SpecificationGoalUIRegistry
-indirectRelationRegistry : IndirectRelationUIRegistry
+SpecificationTreeCanvas(model : GMoDSModel, testDriver : TestDriver)
-createGoalUIs() : void
-createGoalUI(goal : ParameterizedSpecificationGoal, depth : int) : void
+draw() : void
+drawRelations() : void
+initialize() : void
-initializeGoals() : void
-orderGoals() : void
#determineSize() : Dimension
-registerRelations() : void
AbstractTriggerUI
-event : SpecificationEvent
-parameterNames : List<String> = new ArrayList<String>()
#getLabel() : String
NegativeTriggerUI
#getStroke() : Stroke
PositiveTriggerUI
PrecedesRelationUI
#getLabel() : String
IndirectRelations
IndirectRelationUIRegistry
+addRelationUI(relationUI : AbstractRelationUI) : void
+drawRelations(graphics2D : Graphics2D) : void
+sortRelations() : void
+calculateRequiredSize(treeWidth : int) : Dimension
+reset() : void
AbstractCanvas
#image : BufferedImage
#graphics2D : Graphics2D
#model : GMoDSModel
#testDriver : TestDriver
+paintComponent(g : Graphics) : void
+resize() : void
#determineSize() : Dimension
+draw() : void
+initialize() : void
+zoomIn() : void
+resetZoom() : void
+zoomOut() : void
GoalUis
CanvasGoalUis
SpecificationGoalUIRegistry
+put(goalUI : SpecificationGoalUI) : void
+get(identifier : UniqueIdentifier) : SpecificationGoalUI
+getRootUI() : SpecificationGoalUI
+getGoalUIs() : Iterator<SpecificationGoalUI>
+getChildUIs(identifier : UniqueIdentifier) : Iterator<SpecificationGoalUI>
+hasChildren(identifier : UniqueIdentifier) : boolean
+resetGoalUIs() : void
RelationGoalUIs

Figure 50 GMoDS Visualizer Specification Tree View Component Classes

Figure 50 above shows the component design of the specification tree view. Figure 51 below shows the component design of the instance tree view.

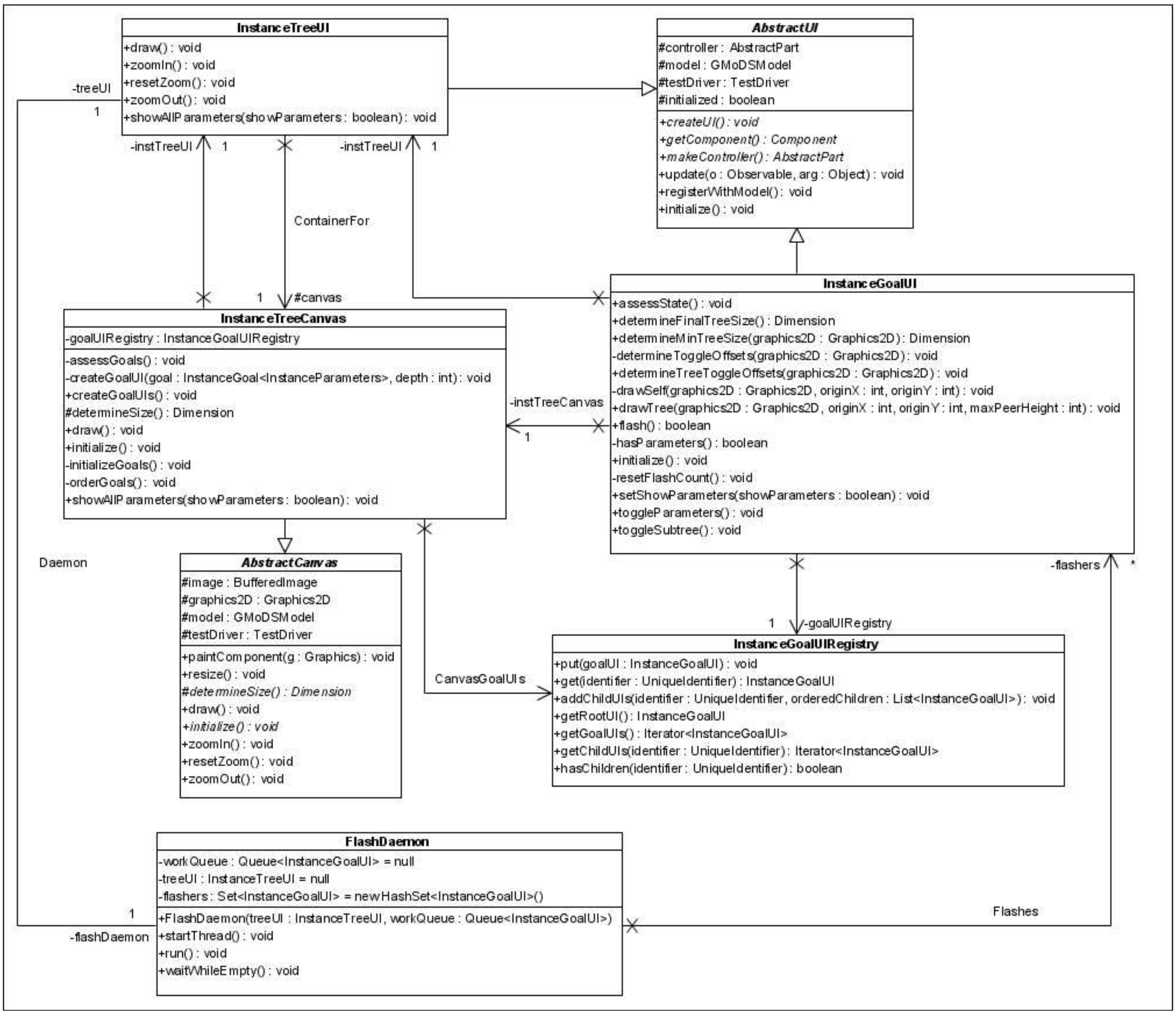

InstanceTreeUI
+draw() : void
+zoomIn() : void
+resetZoom() : void
+zoomOut() : void
+showAllParameters(showParameters : boolean) : void
AbstractUI
#controller : AbstractPart
#model : GMoDSModel
#testDriver : TestDriver
#initialized : boolean
+createUI() : void
+getComponent() : Component
+makeController() : AbstractPart
+update(o : Observable, arg : Object) : void
+registerWithModel() : void
+initialize() : void
-treeUI
1
-instTreeUI
1
-instTreeUI
1
ContainerFor
1
#canvas
InstanceTreeCanvas
-goalUIRegistry : InstanceGoalUIRegistry
-assessGoals() : void
-createGoalUI(goal : InstanceGoal<InstanceParameters>, depth : int) : void
+createGoalUIs() : void
#determineSize() : Dimension
+draw() : void
+initialize() : void
-initializeGoals() : void
-orderGoals() : void
+showAllParameters(showParameters : boolean) : void
InstanceGoalUI
+assessState() : void
+determineFinalTreeSize() : Dimension
+determineMinTreeSize(graphics2D : Graphics2D) : Dimension
-determineToggleOffsets(graphics2D : Graphics2D) : void
+determineTreeToggleOffsets(graphics2D : Graphics2D) : void
-drawSelf(graphics2D : Graphics2D, originX : int, originY : int) : void
+drawTree(graphics2D : Graphics2D, originX : int, originY : int, maxPeerHeight : int) : void
+flash() : boolean
-hasParameters() : boolean
+initialize() : void
-resetFlashCount() : void
+setShowParameters(showParameters : boolean) : void
+toggleParameters() : void
+toggleSubtree() : void
-instTreeCanvas
1
Daemon
AbstractCanvas
#image : BufferedImage
#graphics2D : Graphics2D
#model : GMoDSModel
#testDriver : TestDriver
+paintComponent(g : Graphics) : void
+resize() : void
#determineSize() : Dimension
+draw() : void
+initialize() : void
+zoomIn() : void
+resetZoom() : void
+zoomOut() : void
-flashers
*
1
-goalUIRegistry
InstanceGoalUIRegistry
+put(goalUI : InstanceGoalUI) : void
+get(identifier : UniqueIdentifier) : InstanceGoalUI
+addChildUIs(identifier : UniqueIdentifier, orderedChildren : List<InstanceGoalUI>) : void
+getRootUI() : InstanceGoalUI
+getGoalUIs() : Iterator<InstanceGoalUI>
+getChildUIs(identifier : UniqueIdentifier) : Iterator<InstanceGoalUI>
+hasChildren(identifier : UniqueIdentifier) : boolean
CanvasGoalUIs
FlashDaemon
-workQueue : Queue<InstanceGoalUI> = null
-treeUI : InstanceTreeUI = null
-flashers : Set<InstanceGoalUI> = new HashSet<InstanceGoalUI>()
+FlashDaemon(treeUI : InstanceTreeUI, workQueue : Queue<InstanceGoalUI>)
+startThread() : void
+run() : void
+waitWhileEmpty() : void
1
-flashDaemon
Flashes

Figure 51 GMoDS Visualizer InstanceTreeUI Component Classes

7.2.2.3.1 GMoDS Visualizer View Local Module Responsibilities

Table 36 GMoDS Visualizer View Module Responsibilities

Component	Responsibilities
EditPreferencesUI	Provide the view for editing preferences.
SpecificationTreeUI	Provide the view for the specification tree.
SpecificationTreeCanvas	Draw the specification tree on an image.
SpecificationGoalUI	Provide the view for a specification goal.
AbstractRelationUI	Provide the view for relation UIs.
AbstractTriggerUI	Provide the view for trigger UIs.
PrecedesRelationUI	Provide the view for a “precedes” relation.

Component	Responsibilities
PositiveTriggerUI	Provide the view for a positive trigger.
NegativeTriggerUI	Provide the view for a negative trigger.
SpecificationGoalUIRegistry	Record and provide access to the view of each specification goal.
IndirectRelationUIRegistry	Record and manage the drawing of indirectly routed relation views.
InstanceTreeUI	Provide the view for the instance tree.
InstanceTreeCanvas	Draw the instance tree on an image.
InstanceGoalUI	Provide the view for an instance goal.
InstanceGoalUIRegistry	Record and provide access to the view of each instance goal.
FlashDaemon	Flash each changed InstanceGoalUI.

7.2.2.3.2 GMoDS Visualizer View Local Module Interface Specifications

Table 37 SpecificationTreeUI Interface Specifications

Draw the specification tree on the canvas.	Syntax:	draw() : void
	Pre:	none
	Post:	The specification tree is drawn on the canvas.

Table 38 SpecificationTreeCanvas Interface Specifications

Assure that all instance goals in the instance tree have views.	Syntax:	createGoalUIs() : void
	Pre:	none
	Post:	All instance goals in the instance tree have views.
Create the view for a particular specification goal.	Syntax:	createGoalUI(goal : ParameterizedSpecificationGoal, depth : int) : void
	Pre:	goal != null
	Post:	The specification goal has a view created and recorded.

Draw the specification tree on the canvas.	Syntax:	draw() : void
	Pre:	none
	Post:	The specification tree is drawn on the canvas.
Draw all relations.	Syntax:	drawRelations() : void
	Pre:	none
	Post:	All relations are drawn.
Initialize the canvas.	Syntax:	initialize() : void
	Pre:	none
	Post:	The canvas is initialized.
Initialize all specification goal views.	Syntax:	initializeGoals() : void
	Pre:	none
	Post:	All specification goal views are initialized.
Order the goals at each level of the specification tree to draw relations from left to right.	Syntax:	orderGoals() : void
	Pre:	none
	Post:	The goals at each level of the specification tree are ordered so relations can be drawn from left to right.
Determine the dimensions of the specification tree image.	Syntax:	determineSize() : Dimension
	Pre:	none
	Post:	Result – the total size of the specification tree image is returned.
Register and sort all relations.	Syntax:	registerRelations() : void
	Pre:	none
	Post:	All relations are registered with the appropriate views and registries and are sorted for drawing order.

Table 39 SpecificationGoalUI Interface Specifications

Determine the minimum size of the specification tree image.	Syntax:	determineMinTreeSize(graphics2D : Graphics2D) : Dimension
	Pre:	graphics2D != null
	Post:	Result = the minimum dimensions of the specification tree image.
Determine the horizontal offsets required to provide space for relations in the tree.	Syntax:	determineTreeRelationOffsets(graphics2D : Graphics2D) : void
	Pre:	graphics2D != null
	Post:	Each SpecificationGoalUI has recorded its required horizontal offset.
Determine the final overall size of the specification tree image.	Syntax:	determineFinalTreeSize() : Dimension
	Pre:	none
	Post:	Result = the final dimensions of the specification tree image.
Draw the specification tree rooted at this SpecificationGoalUI on the canvas.	Syntax:	drawTree(graphics2D : Graphics2D, originX : int, originY : int, maxPeerHeight : int) : void
	Pre:	graphics2D != null
	Post:	The specification tree rooted at this SpecificationGoalUI is drawn on the canvas.
Draw the SpecificationGoalUI on the canvas.	Syntax:	drawSelf(graphics2D : Graphics2D, originX : int, originY : int) : void
	Pre:	graphics2D != null
	Post:	The SpecificationGoalUI is drawn on the canvas.
Draw the directly-routed relations emanating from the SpecificationGoalUI on the canvas.	Syntax:	drawDirectRelations(graphics2D : Graphics2D) : void
	Pre:	graphics2D != null
	Post:	The directly-routed relations emanating from the SpecificationGoalUI are drawn on the canvas.

Table 40 AbstractRelationUI Interface Specifications

Determine whether the relation will be directly or indirectly routed.	Syntax:	determineRouting() : void
	Pre:	none
	Post:	The AbstractRelationUI has recorded whether the relation will be directly or indirectly routed.
Determine the horizontal offset required for the destination SpecificationGoalUI.	Syntax:	determineOffsets(graphics2D : Graphics2D) : void
	Pre:	graphics2D != null
	Post:	The destination SpecificationGoalUI has recorded the horizontal offset required for this AbstractRelationUI.
Query the required label for the relation.	Syntax:	getLabel() : String
	Pre:	none
	Post:	Result = the required label for the relation.
Draw the relation on the canvas.	Syntax:	draw(graphics2D : Graphics2D) : void
	Pre:	graphics2D != null
	Post:	The relation is drawn on the canvas.

Table 41 SpecificationGoalUIRegistry Interface Specifications

Record a SpecificationGoalUI.	Syntax:	put(goalUI : SpecificationGoalUI) : void
	Pre:	goalUI != null
	Post:	Recorded the SpecificationGoalUI.
Access a SpecificationGoalUI.	Syntax:	get(identifier : UniqueIdentifier) : SpecificationGoalUI
	Pre:	identifier != null
	Post:	Result = the SpecificationGoalUI.
Access the root SpecificationGoalUI.	Syntax:	getRootUI() : SpecificationGoalUI
	Pre:	none
	Post:	Result = the root SpecificationGoalUI.

Access all SpecificationGoalUIs.	Syntax:	getGoalUIs() : Iterator<SpecificationGoalUI>
	Pre:	none
	Post:	Result = all SpecificationGoalUIs.
Access all children UIs of the specified SpecificationGoalUI.	Syntax:	getChildUIs(identifier : UniqueIdentifier) : Iterator<SpecificationGoalUI>
	Pre:	identifier != null
	Post:	Result = all children UIs of the specified SpecificationGoalUI.
Query whether a SpecificationGoalUI has children.	Syntax:	hasChildren(identifier : UniqueIdentifier) : boolean
	Pre:	identifier != null
	Post:	Result = true if the SpecificationGoalUI has children; false, otherwise.
Reset all SpecificationGoalUIs data structures that support drawing.	Syntax:	resetGoalUIs() : void
	Pre:	none
	Post:	All SpecificationGoalUIs data structures that support drawing are reset to their default values.

Table 42 IndirectRelationUIRegistry Interface Specifications

Record an indirectly-routed AbstractRelationUI.	Syntax:	addRelationUI(relationUI : AbstractRelationUI) : void
	Pre:	relationUI != null
	Post:	The indirectly-routed AbstractRelationUI is recorded.
Draw the all indirectly-routed AbstractRelationUIs on the canvas.	Syntax:	drawRelations(graphics2D : Graphics2D) : void
	Pre:	graphics2D != null
	Post:	All indirectly-routed AbstractRelationUIs are drawn on the canvas.

Sort all indirectly-routed AbstractRelationUIs into drawing order.	Syntax:	sortRelations() : void
	Pre:	none
	Post:	All indirectly-routed AbstractRelationUIs are sorted into drawing order.
Calculate the size required for indirectly-routed relations below the specification tree.	Syntax:	calculateRequiredSize(width : int) : Dimension
	Pre:	none
	Post:	Result = the size required for indirectly-routed relations below the specification tree.
Reset indirectly-routed AbstractRelationUIs data structures that support drawing.	Syntax:	reset() : void
	Pre:	none
	Post:	All indirectly-routed AbstractRelationUIs data structures that support drawing are reset to their default values.

Table 43 InstanceTreeUI

Draw the instance tree on the canvas.	Syntax:	draw() : void
	Pre:	none
	Post:	The instance tree is drawn on the canvas.
Record whether all parameters should be shown in the instance tree.	Syntax:	showAllParameters(showParameters : boolean) : void
	Pre:	none
	Post:	Recorded whether all parameters should be shown in the instance tree.

Table 44 InstanceTreeCanvas Interface Specifications

Assess the GoalState of all InstanceGoalUIs.	Syntax:	assessGoals() : void
	Pre:	none
	Post:	The GoalState of each InstanceGoalUI is recorded.

Create an InstanceGoalUI.	Syntax:	createGoalUI(goal : InstanceGoal<InstanceParameters>, depth : int) : void
	Pre:	goal != null
	Post:	An InstanceGoalUI is created for goal and is recorded in the InstanceGoalUIRegistry.
Create all InstanceGoalUIs if they don’t exist already.	Syntax:	createGoalUIs() : void
	Pre:	none
	Post:	An InstanceGoalUI is created for each goal in GMoDS if it does not already exist and is recorded in the InstanceGoalUIRegistry.
Determine the dimensions of the instance tree image.	Syntax:	determineSize() : Dimension
	Pre:	none
	Post:	Result – the total size of the instance tree image is returned.
Draw the instance tree on the canvas.	Syntax:	draw() : void
	Pre:	none
	Post:	The instance tree is drawn on the canvas.
Initialize the canvas.	Syntax:	initialize() : void
	Pre:	none
	Post:	The canvas is initialized.
Initialize all instance goal views.	Syntax:	initializeGoals() : void
	Pre:	none
	Post:	All specification goal views are initialized.
Order the goals at each level of the instance tree alphabetically.	Syntax:	orderGoals() : void
	Pre:	none
	Post:	The goals at each level of the instance tree are ordered alphabetically.

Record whether all parameters should be shown in the instance tree.	Syntax:	showAllParameters(showParameters : boolean) : void
	Pre:	none
	Post:	Recorded whether all parameters should be shown in the instance tree.

Table 45 InstanceGoalUI Interface Specifications

Assess the GoalState of the InstanceGoalUI.	Syntax:	assessState() : void
	Pre:	none
	Post:	The GoalState of the InstanceGoalUI is recorded.
Determine the final dimensions of the instance tree rooted at this InstanceGoalUI.	Syntax:	determineFinalTreeSize() : Dimension
	Pre:	none
	Post:	Result – the total size of the instance tree rooted at this InstanceGoalUI is returned.
Determine the minimum dimensions of the instance tree rooted at this InstanceGoalUI.	Syntax:	determineMinTreeSize() : Dimension
	Pre:	none
	Post:	Result – the minimum size of the instance tree rooted at this InstanceGoalUI is returned.
Determine the horizontal offset required to accommodate parameter toggles for the InstanceGoalUIs in the tree rooted at this InstanceGoalUI.	Syntax:	determineTreeToggleOffsets() : Dimension
	Pre:	none
	Post:	The horizontal offset required to accommodate parameter toggles for the InstanceGoalUIs in the tree rooted at this InstanceGoalUI are recorded with each InstanceGoalUI.
Draw this InstanceGoalUI on the canvas.	Syntax:	drawSelf(graphics2D : Graphics2D, originX : int, originY : int) : void
	Pre:	none
	Post:	This InstanceGoalUI is drawn on the canvas.

Draw the instance tree rooted at this InstanceGoalUI on the canvas.	Syntax:	drawTree(graphics2D : Graphics2D, originX : int, originY : int, maxPeerHeight : int) : void
	Pre:	none
	Post:	The instance tree rooted at this InstanceGoalUI is drawn on the canvas.
Invert the colors for this InstanceGoalUI to represent a flash and decrement the remaining flash count when the inversion has cycled back to normal.	Syntax:	flash() : boolean
	Pre:	none
	Post:	The color for this InstanceGoalUI is inverted and the remaining flash count is decremented when the inversion has cycled back to normal. Result – false if remaining flash count <= 0; true otherwise.
Query whether this InstanceGoalUI has parameters.	Syntax:	hasParameters() : boolean
	Pre:	none
	Post:	Result – true if this InstanceGoalUI has parameters; false, otherwise.
Initialize the InstanceGoalUI and recreate the labels.	Syntax:	initialize() : void
	Pre:	none
	Post:	The InstanceGoalUI is initialized and the labels are recreated.
Reset the flash count to the current total required by FlashParameters.	Syntax:	resetFlashCount() : void
	Pre:	none
	Post:	The remaining flash count is reset to the current total required by FlashParameters.
Record whether this InstanceGoalUI should show its parameters.	Syntax:	setShowParameters(showParameters : boolean) : void
	Pre:	none
	Post:	Recorded whether this InstanceGoalUI should show its parameters.

Toggle whether this InstanceGoalUI should show its parameters.	Syntax:	toggleParameters() : void
	Pre:	none
	Post:	Toggled whether this InstanceGoalUI should show its parameters.
Toggle whether this InstanceGoalUI should show its children.	Syntax:	toggleSubtree() : void
	Pre:	none
	Post:	Toggled whether this InstanceGoalUI should show its children.

Table 46 InstanceGoalUIRegistry

Record an InstanceGoalUI.	Syntax:	put(goalUI : InstanceGoalUI) : void
	Pre:	goalUI != null
	Post:	Recorded the InstanceGoalUI.
Access an InstanceGoalUI.	Syntax:	get(identifier : UniqueIdentifier) : InstanceGoalUI
	Pre:	identifier != null
	Post:	Result = the InstanceGoalUI.
Access the root InstanceGoalUI.	Syntax:	getRootUI() : InstanceGoalUI
	Pre:	none
	Post:	Result = the root InstanceGoalUI.
Access all InstanceGoalUIs.	Syntax:	getGoalUIs() : Iterator<InstanceGoalUI>
	Pre:	none
	Post:	Result = all InstanceGoalUIs.
Access all children UIs of the specified InstanceGoalUI.	Syntax:	getChildUIs(identifier : UniqueIdentifier) : Iterator<InstanceGoalUI>
	Pre:	identifier != null
	Post:	Result = all children UIs of the specified InstanceGoalUI.

Query whether an InstanceGoalUI has children.	Syntax:	hasChildren(identifier : UniqueIdentifier) : boolean
	Pre:	identifier != null
	Post:	Result = true if the InstanceGoalUI has children; false, otherwise.

Table 47 FlashDaemon Interface Specifications

Start the thread for the FlashDaemon.run method.	Syntax:	startThread() : void
	Pre:	none
	Post:	The thread for the FlashDaemon.run method is started.
Flash all changed InstanceGoalUIs.	Syntax:	run() : void
	Pre:	none
	Post:	Flashed all changed InstanceGoalUIs for the total times implied by FlashParameters at the time the goal changed.
Wait until a changed InstanceGoalUI is added to the daemon.	Syntax:	waitWhileEmpty() : void
	Pre:	none
	Post:	A changed InstanceGoalUI has been added to the daemon.

7.2.2.3.3 GMoDS Visualizer View Design Rationale

The Model-View-Controller architecture separates the business rules for interacting with the user away from the presentation of the interface. This will allow for maximum flexibility in designing new visual representations.

7.2.2.4 GMoDS Visualizer View Behavior

Figure 52 below shows the SpecificationTreeUI.initialize() method.

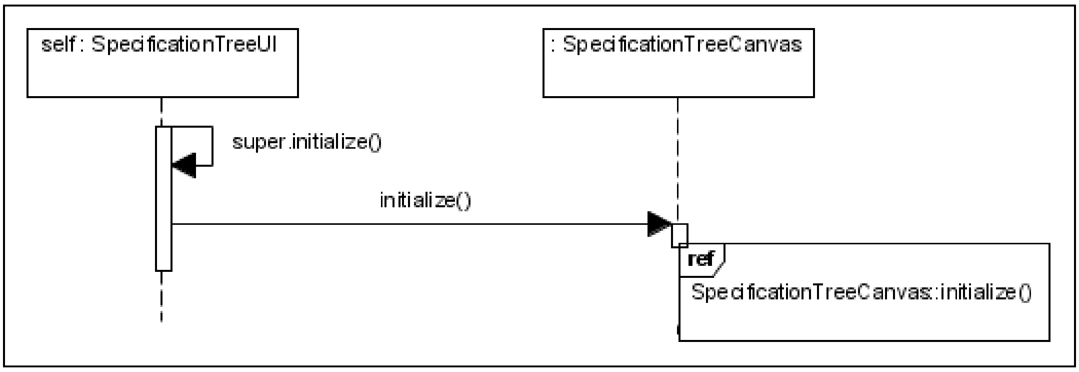

self : SpecificationTreeUI
: SpecificationTreeCanvas
super.initialize()
initialize()
ref
SpecificationTreeCanvas::initialize()

Figure 52 SpecificationTreeUI.initialize()

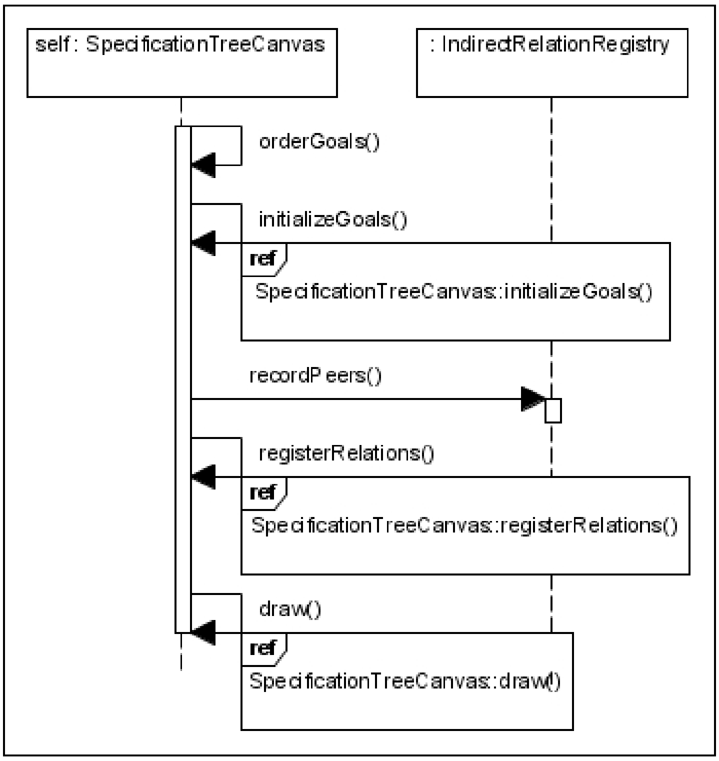

self : SpecificationTreeCanvas
: IndirectRelationRegistry
orderGoals()
initializeGoals()
ref
SpecificationTreeCanvas::initializeGoals()
recordPeers()
registerRelations()
ref
SpecificationTreeCanvas::registerRelations()
draw()
ref
SpecificationTreeCanvas::draw()

Figure 53 SpecificationTreeCanvas.initialize()

Figure 53 above shows the SpecificationTreeCanvas.initialize method. Figure 54 below shows the SpecificationTreeCanvas.initializeGoals method.

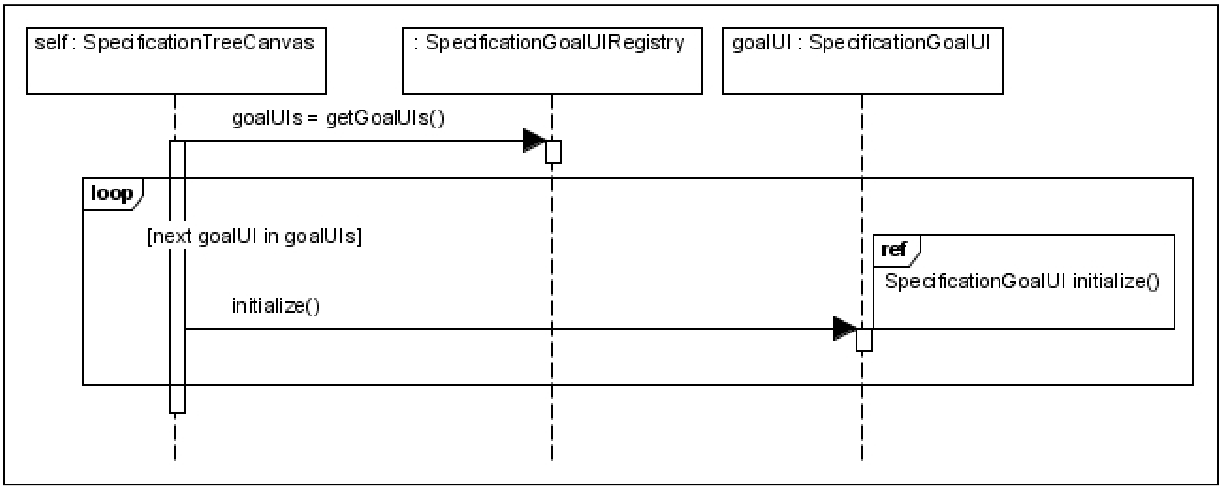

self : SpecificationTreeCanvas
: SpecificationGoalUIRegistry
goalUI : SpecificationGoalUI
goalUIs = getGoalUIs()
loop
[next goalUI in goalUIs]
ref
SpecificationGoalUI initialize()
initialize()

Figure 54 SpecificationTreeCanvas.initializeGoals()

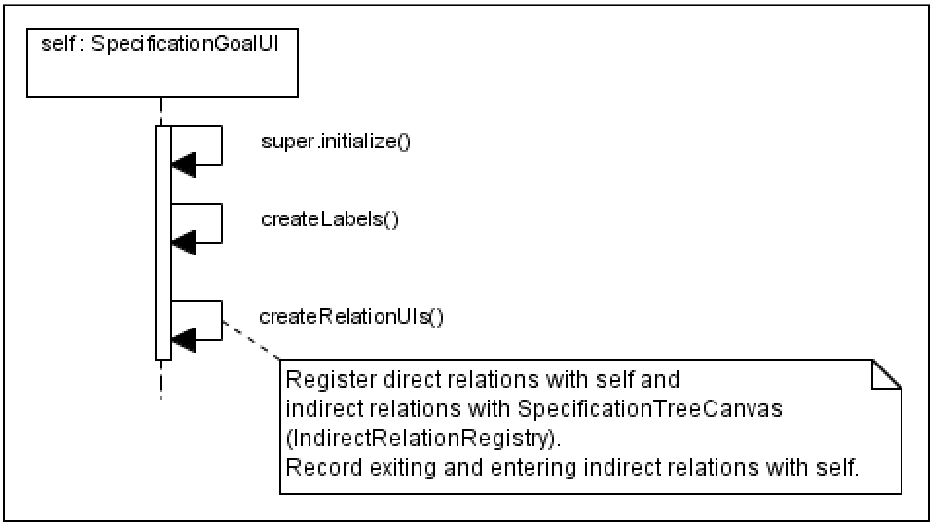

self : SpecificationGoalUI
super.initialize()
createLabels()
createRelationUIs()
Register direct relations with self and
indirect relations with SpecificationTreeCanvas
(IndirectRelationRegistry).
Record exiting and entering indirect relations with self.

Figure 55 SpecificationGoalUI.initialize()

Figure 55 above shows the SpecificationGoalUI.initialize method. Figure 56 below shows the SpecificationTreeCanvas.registerRelations method. This method prepares for drawing relations by recording the relations with the object responsible for drawing them and sorting them in drawing order.

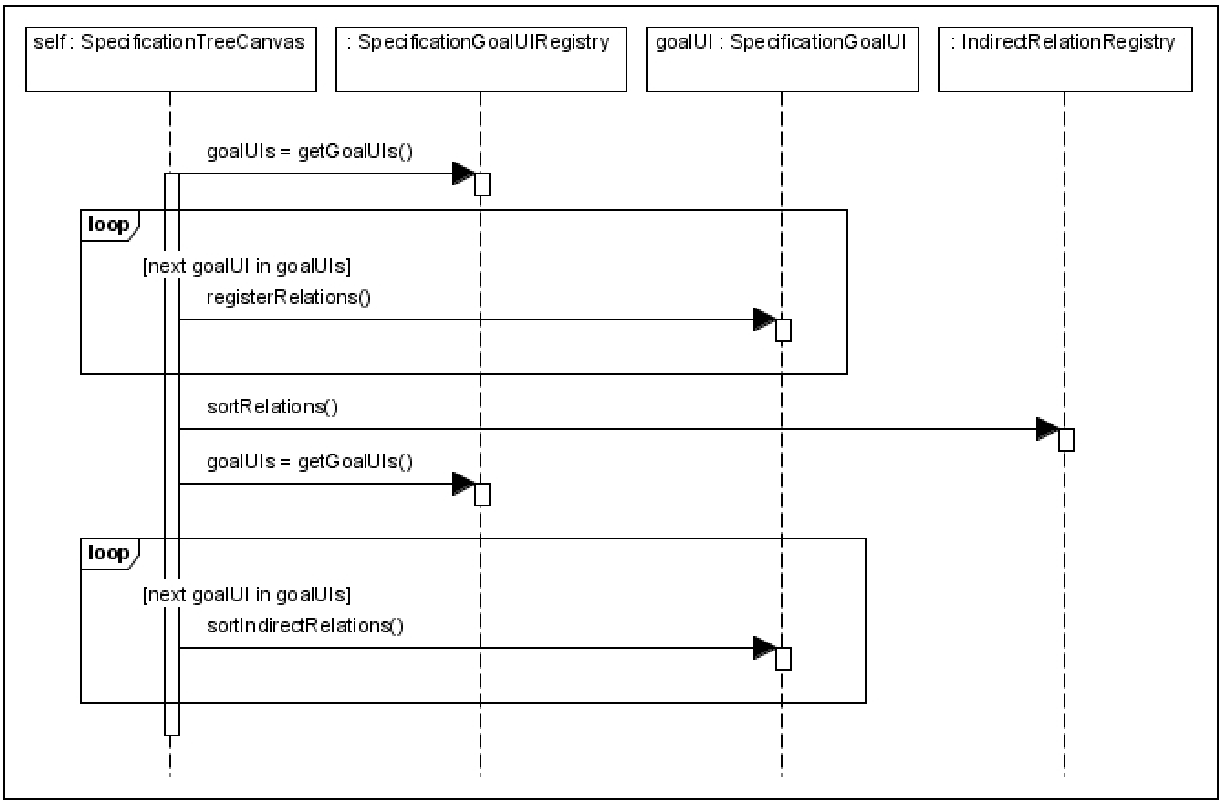


Figure 56 SpecificationTreeCanvas.registerRelations()

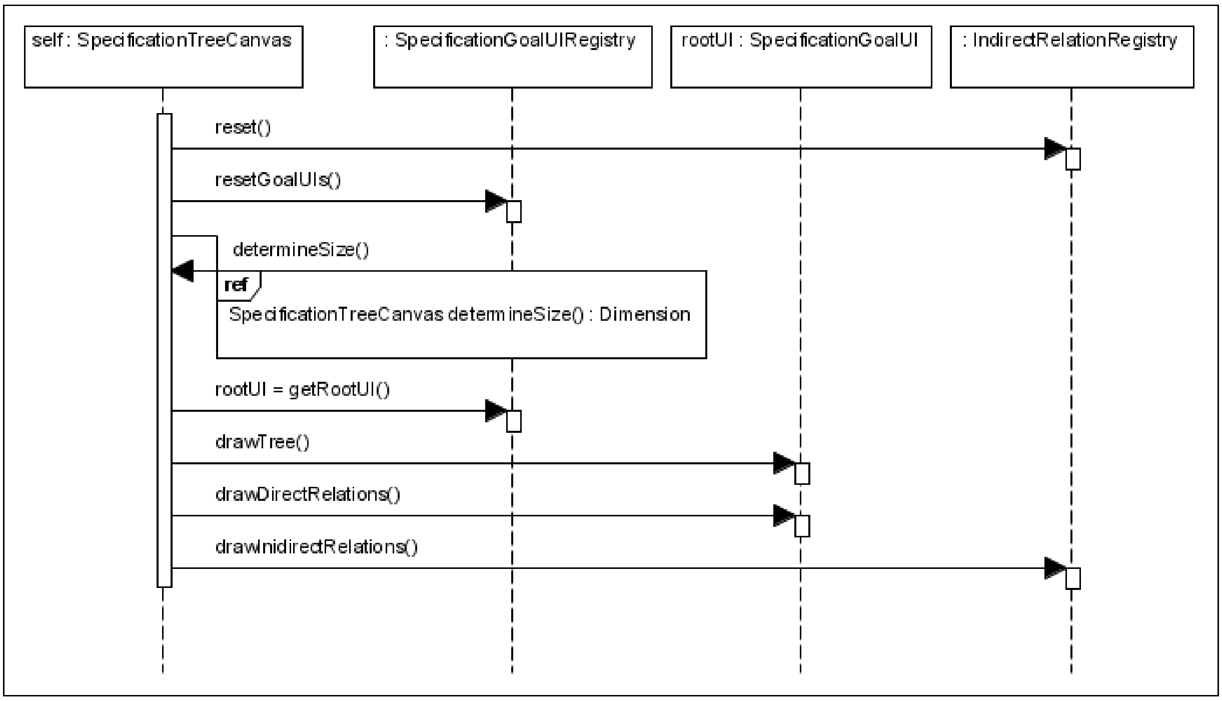

self : SpecificationTreeCanvas
: SpecificationGoalUIRegistry
rootUI : SpecificationGoalUI
: IndirectRelationRegistry
reset()
resetGoalUIs()
determineSize()
ref
SpecificationTreeCanvas.determineSize() : Dimension
rootUI = getRootUI()
drawTree()
drawDirectRelations()
drawInidirectRelations()

Figure 57 SpecificationTreeCanvas.draw()

Figure 57 above shows the SpecificationTreeCanvas.draw method. First, all SpecificationGoalUIs and AbstractRelationUIs data structures that are dynamically calculated during drawing are reset to their default values. Next, the canvas is triggered to determine the total size of its image. Finally, the tree and the directly-routed and indirectly-routed relations are drawn. Figure 58 below shows the SpecificationTreeCanvas.determineSize method.

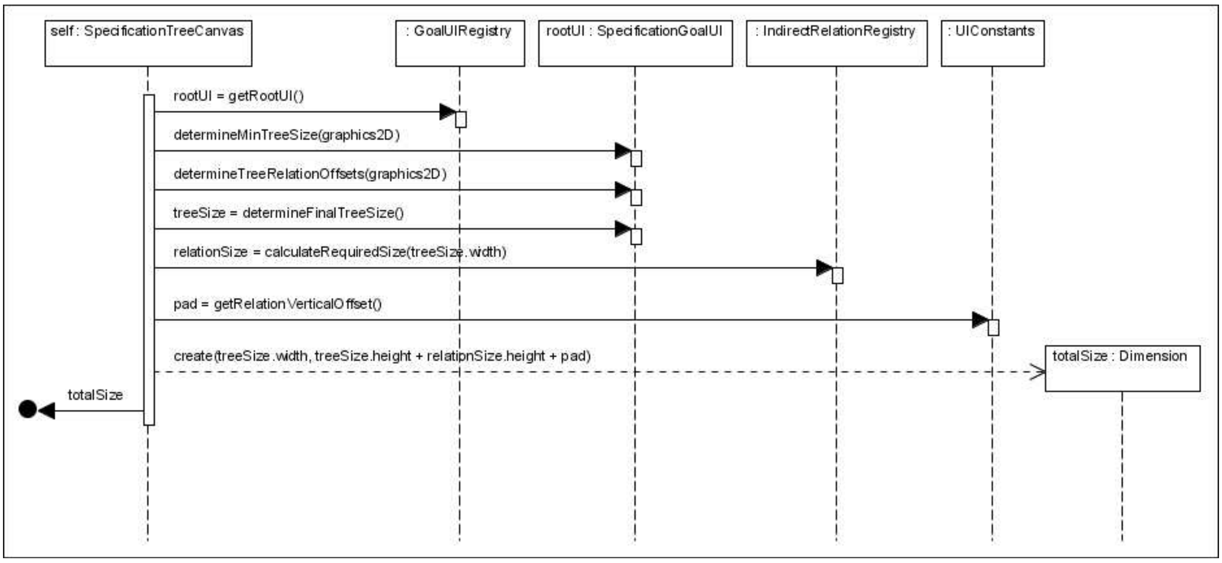

self : SpecificationTreeCanvas
: GoalUIRegistry
rootUI : SpecificationGoalUI
: IndirectRelationRegistry
: UIConstants
rootUI = getRootUI()
determineMinTreeSize(graphics2D)
determineTreeRelationOffsets(graphics2D)
treeSize = determineFinalTreeSize()
relationSize = calculateRequiredSize(treeSize.width)
pad = getRelationVerticalOffset()
create(treeSize.width, treeSize.height + relationSize.height + pad)
totalSize : Dimension
totalSize

Figure 58 SpecificationTreeCanvas.determineSize()

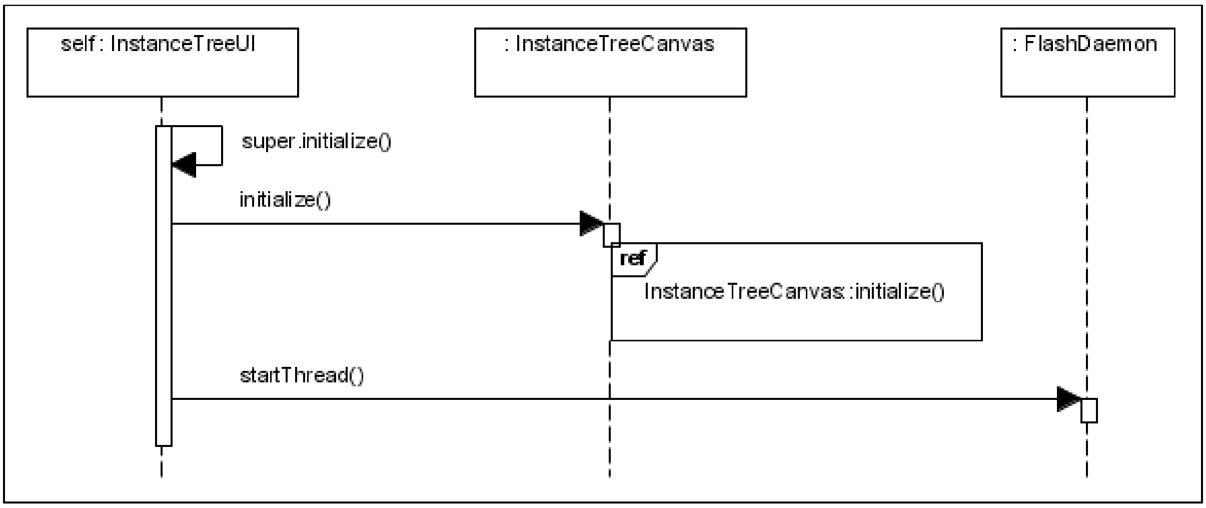


Figure 59 InstanceTreeUI.initialize()

Figure 59 above shows the InstanceTreeUI.initialize method. Figure 60 below shows the InstanceTreeCanvas.initialize method.

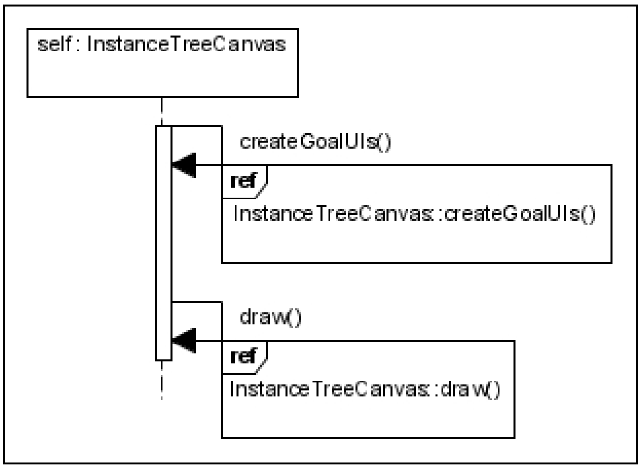

self : InstanceTreeCanvas
createGoalUIs()
ref
InstanceTreeCanvas::createGoalUIs()
draw()
ref
InstanceTreeCanvas::draw()

Figure 60 InstanceTreeCanvas.initialize()

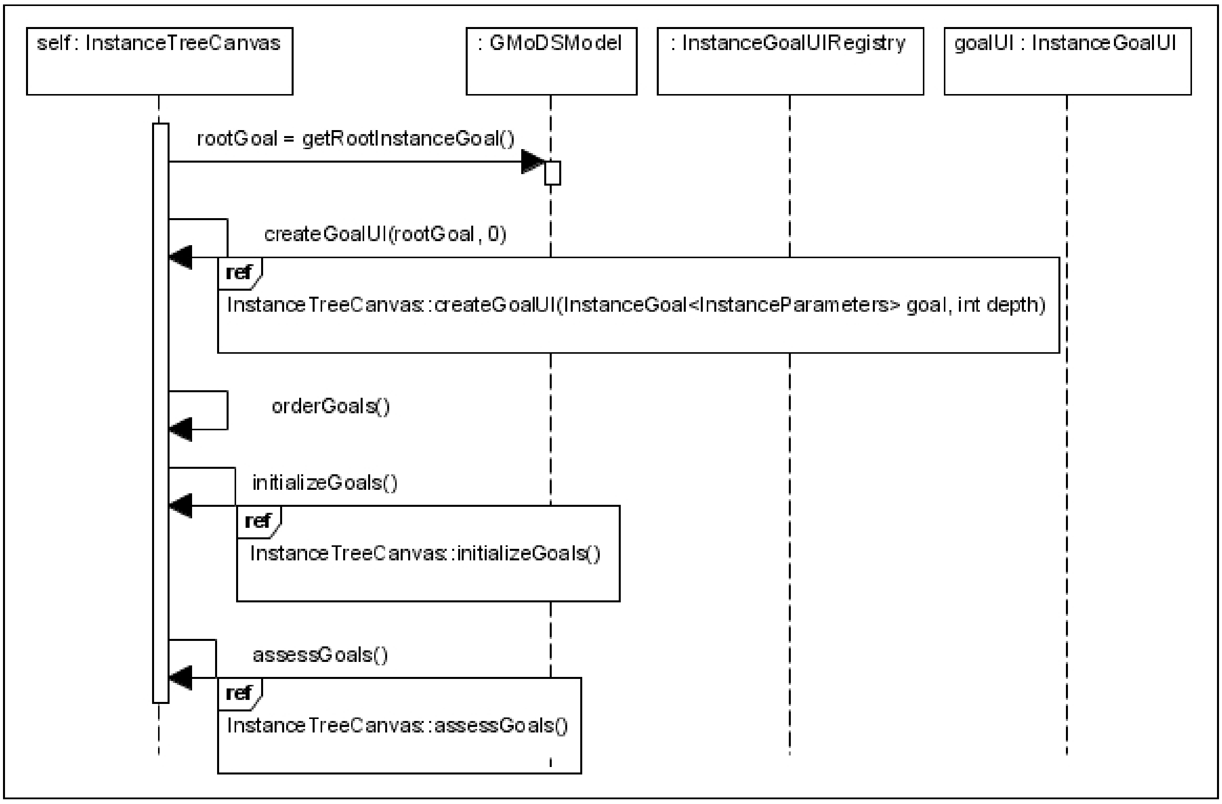

self : InstanceTreeCanvas
: GMoDSModel
: InstanceGoalUIRegistry
goalUI : InstanceGoalUI
rootGoal = getRootInstanceGoal()
createGoalUI(rootGoal, 0)
ref
InstanceTreeCanvas::createGoalUI(InstanceGoal<InstanceParameters> goal, int depth)
orderGoals()
initializeGoals()
ref
InstanceTreeCanvas::initializeGoals()
assessGoals()
ref
InstanceTreeCanvas::assessGoals()

Figure 61 InstanceTreeCanvas.createGoalUIs()

Figure 61 above shows the InstanceTreeCanvas.createGoalUIs method. Using recursion, each an InstanceGoalUI is created for each InstanceGoal in GMoDS. The goal UIs are ordered to support drawing. Each goal UI is intitialized and its GoalState is assessed. Figure 62 below shows the InstanceTreeCanvas.createGoalUI method.

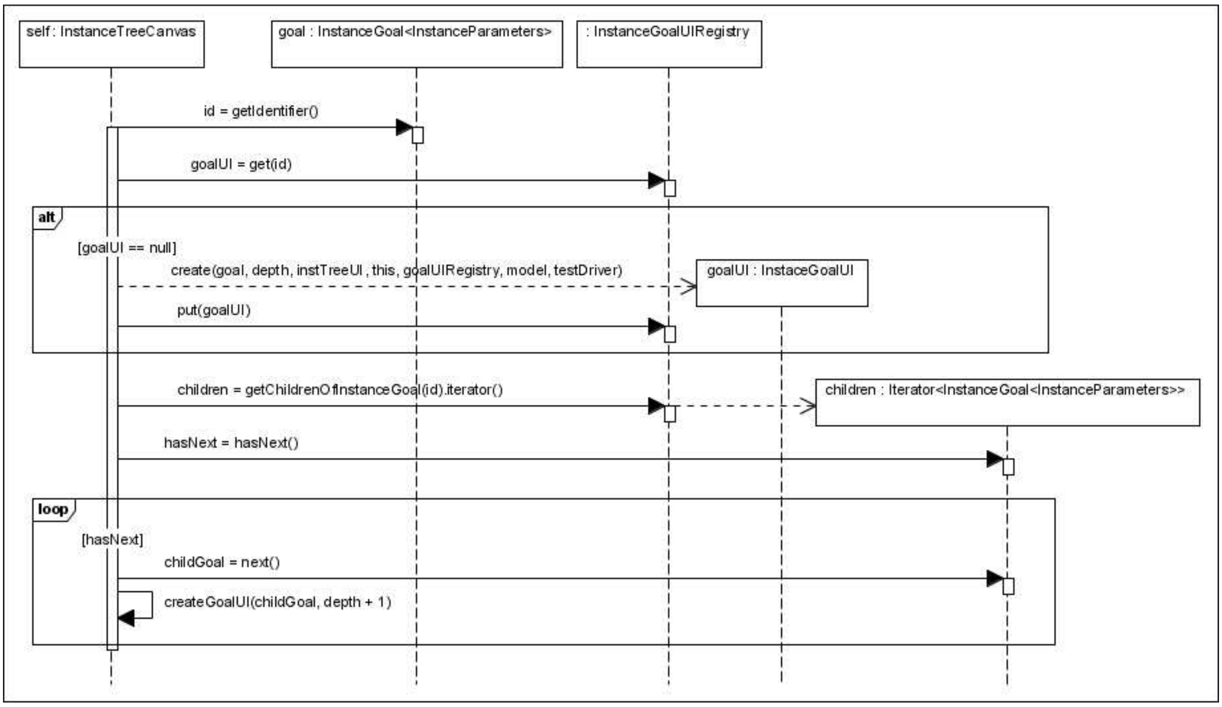

self : InstanceTreeCanvas
goal : InstanceGoal<InstanceParameters>
: InstanceGoalUIRegistry
id = getIdentifier()
goalUI = get(id)
alt
[goalUI == null]
create(goal, depth, instTreeUI, this, goalUIRegistry, model, testDriver)
goalUI : InstaceGoalUI
put(goalUI)
children = getChildrenOfInstanceGoal(id).iterator()
children : Iterator<InstanceGoal<InstanceParameters>>
hasNext = hasNext()
loop
[hasNext]
childGoal = next()
createGoalUI(childGoal, depth + 1)

Figure 62 InstanceTreeCanvas.createGoalUI(goal : InstanceGoal<InstanceParameter> goal, depth :int)

Figure 63 below shows the InstanceTreeCanvas.initializeGoals method.

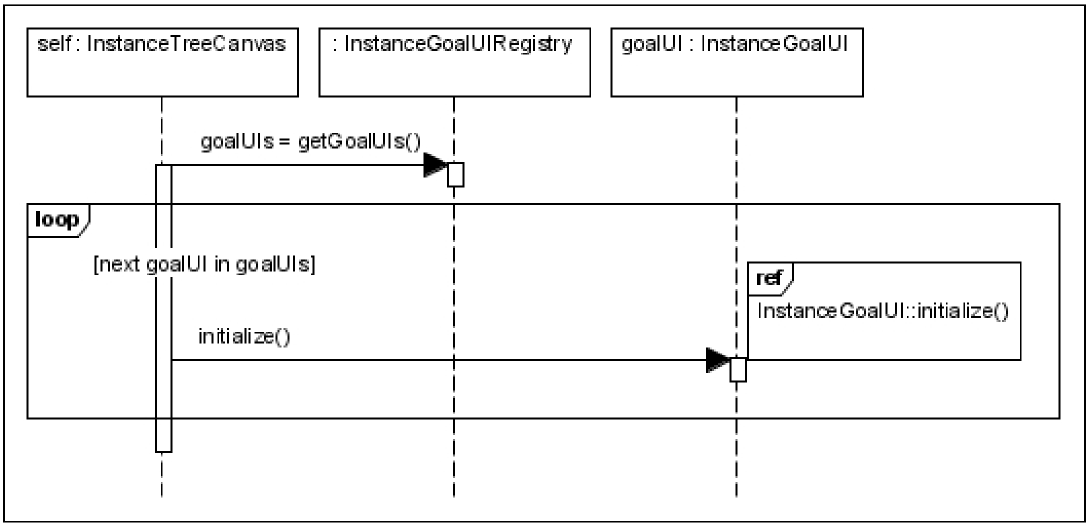


Figure 63 InstanceTreeCanvas.initializeGoals()

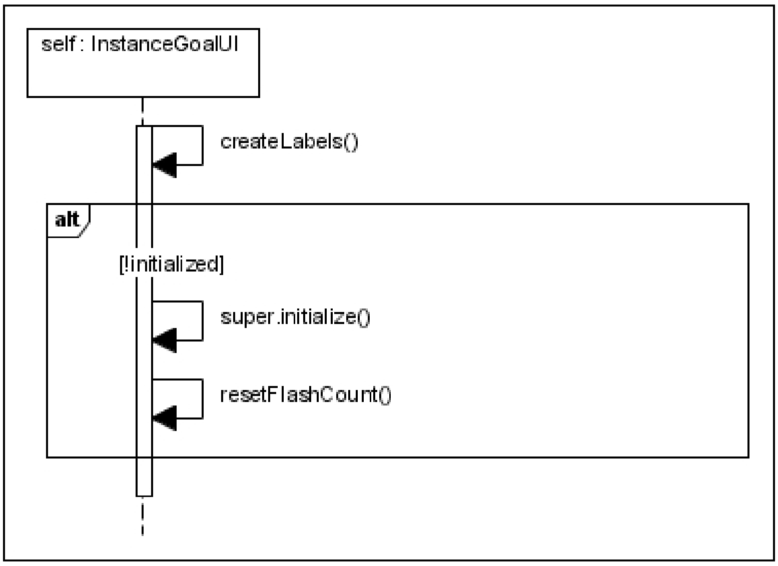


Figure 64 InstanceGoalUI.initialize()

Figure 64 above shows the InstanceGoalUI.initialize method. Figure 65 below shows the InstanceTreeCanvas.assessGoals method.

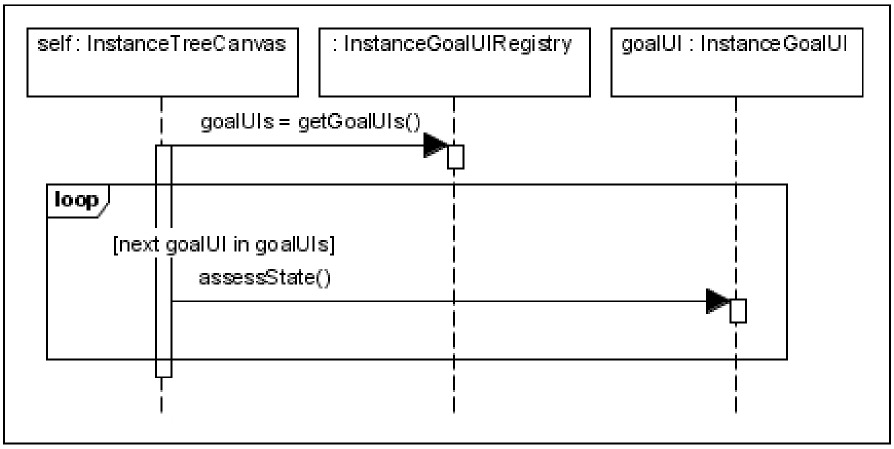


Figure 65 InstanceTreeCanvas.assessGoals()

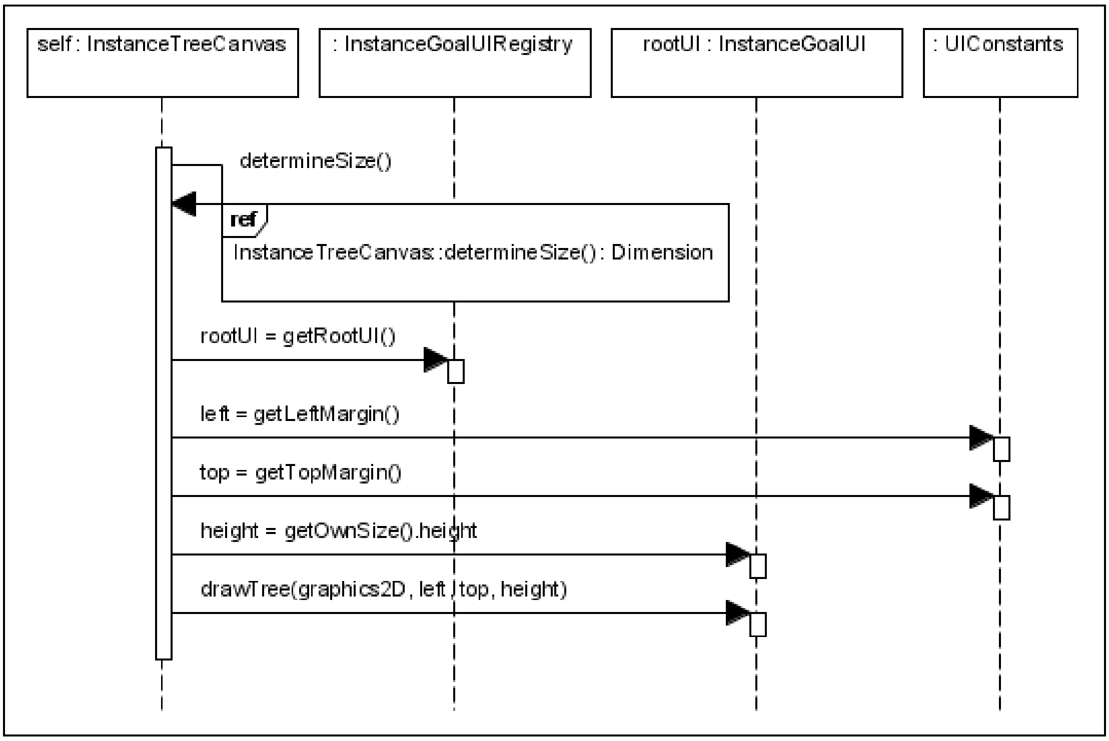


Figure 66 InstanceTreeCanvas.draw()

Figure 66 above shows the InstanceTreeCanvas.draw method. Figure 67 below shows the InstanceTreeCanvas.determineSize method.

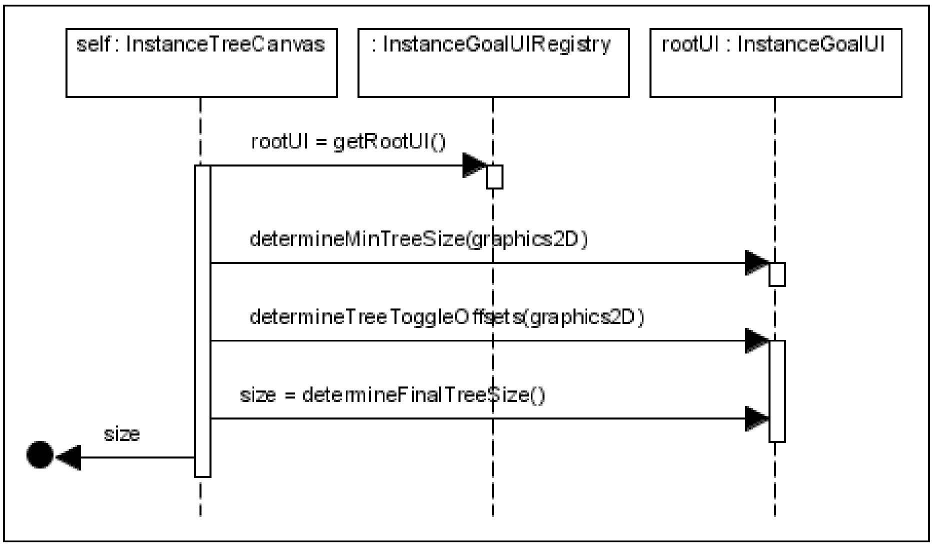

self : InstanceTreeCanvas
: InstanceGoalUIRegistry
rootUI : InstanceGoalUI
rootUI = getRootUI()
determineMinTreeSize(graphics2D)
determineTreeToggleOffsets(graphics2D)
size = determineFinalTreeSize()
size

Figure 67 InstanceTreeCanvas.determineSize() : Dimension

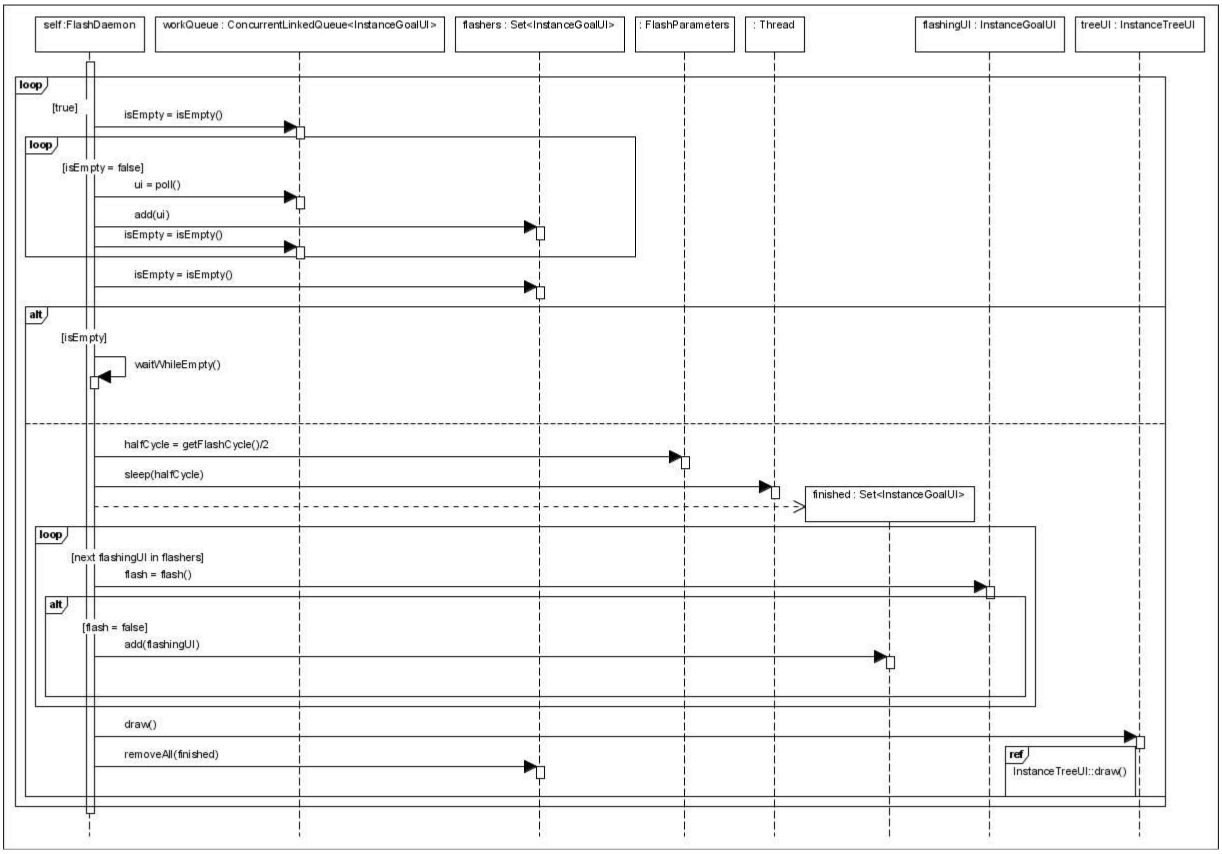


Figure 68 FlashDaemon.run()

Figure 68 above shows the FlashDaemon.run method. The daemon polls its queue for changed InstanceGoalUIs. If none are present, it waits. If at least one is present that has not finished flashing, it waits for a half flashing cycle and then toggles each changed InstanceGoalUI recording whether that UI is finished. Finally, the daemon asks the InstanceTreeUI to draw and then removes the finished UIs. This loop repeats indefinitely until the visualizer exits.

Figure 69 below shows the InstanceTreeUI.draw method.

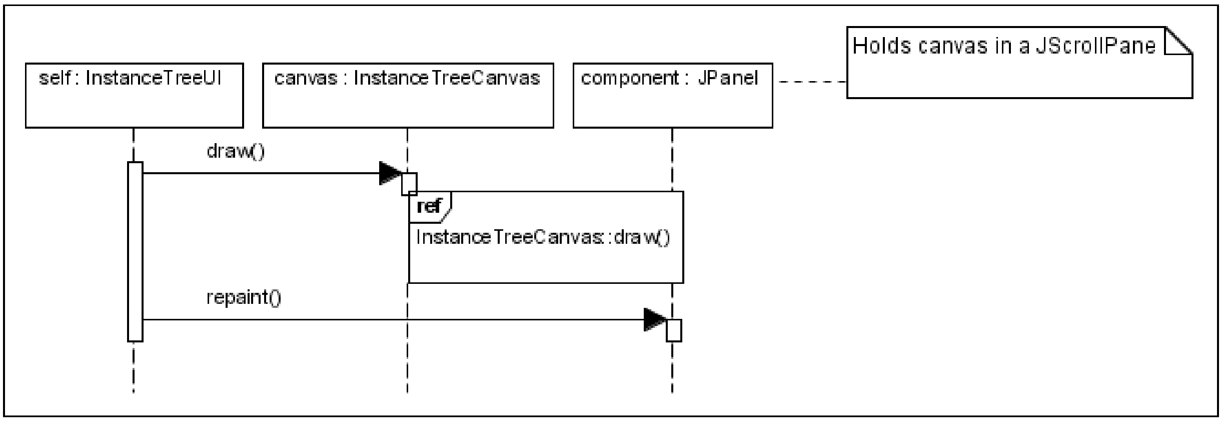

self : InstanceTreeUI
canvas : InstanceTreeCanvas
component : JPanel
Holds canvas in a JScrollPane
draw()
ref
InstanceTreeCanvas::draw()
repaint()

Figure 69 InstanceTreeUI.draw()

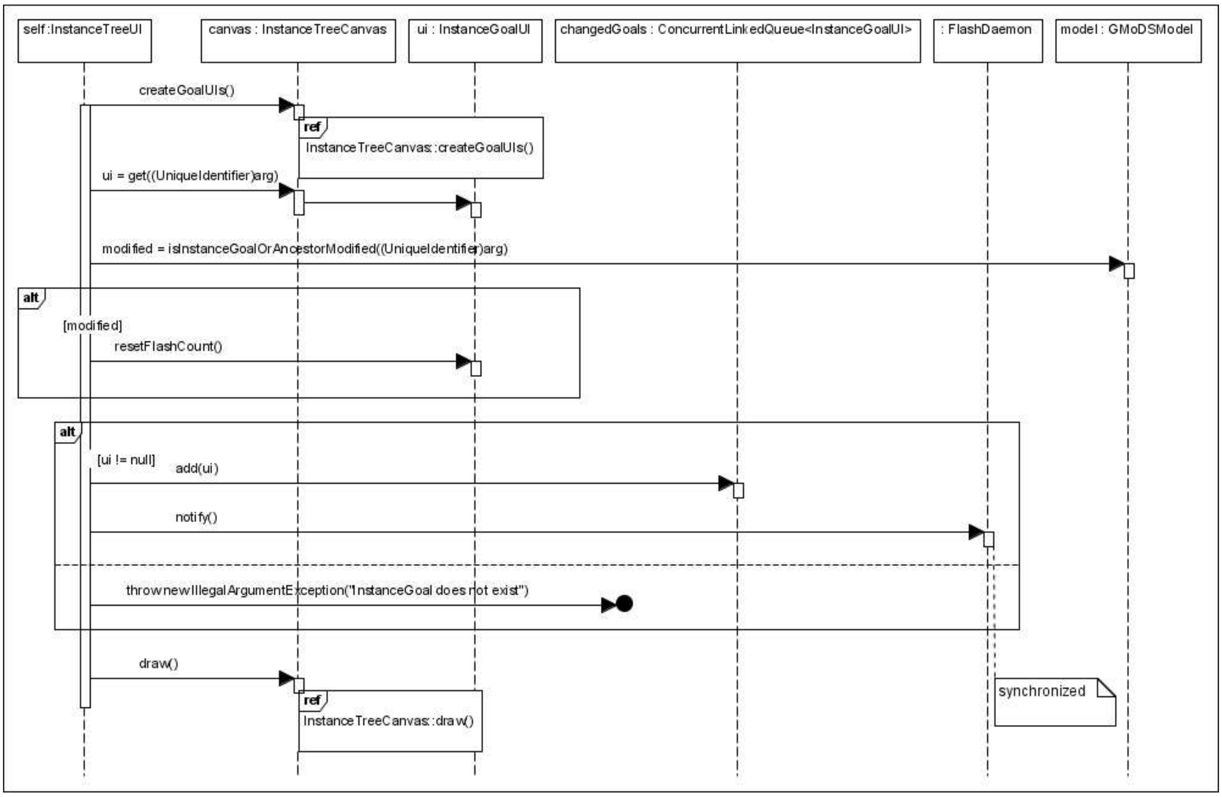

self :InstanceTreeUI
canvas : InstanceTreeCanvas
ui : InstanceGoalUI
changedGoals : ConcurrentLinkedQueue<InstanceGoalUI>
: FlashDaemon
model : GMoDSModel
createGoalUIs()
ref
InstanceTreeCanvas::createGoalUIs()
ui = get((UniqueIdentifier)arg)
modified = isInstanceGoalOrAncestorModified((UniqueIdentifier)arg)
alt
[modified]
resetFlashCount()
alt
[ui != null]
add(ui)
notify()
throw new IllegalArgumentException("InstanceGoal does not exist")
draw()
ref
InstanceTreeCanvas::draw()
synchronized

Figure 70 InstanceTreeUI.update(o : Observable, arg : Object)

Figure 70 above shows the InstanceTreeUI.update method. This method implements the observer design pattern on the GMoDSModel. The GMoDSModel implements the ChangeManager interface and notifies the InstanceTreeUI whenever an InstanceGoal has changed its GoalState or been modified. In response, the InstanceTreeUI assures that an InstanceGoalUI exists and is initialized for each InstanceGoal. Then the InstanceTreeUI notifies the FlashDaemon using a synchronized call to the notify method. Finally, the InstanceTreeCanvas is activated to draw the instance tree (and will be re-activated on each flash by the daemon).

7.2.2.5 GMoDS Visualizer Controller Static Structure

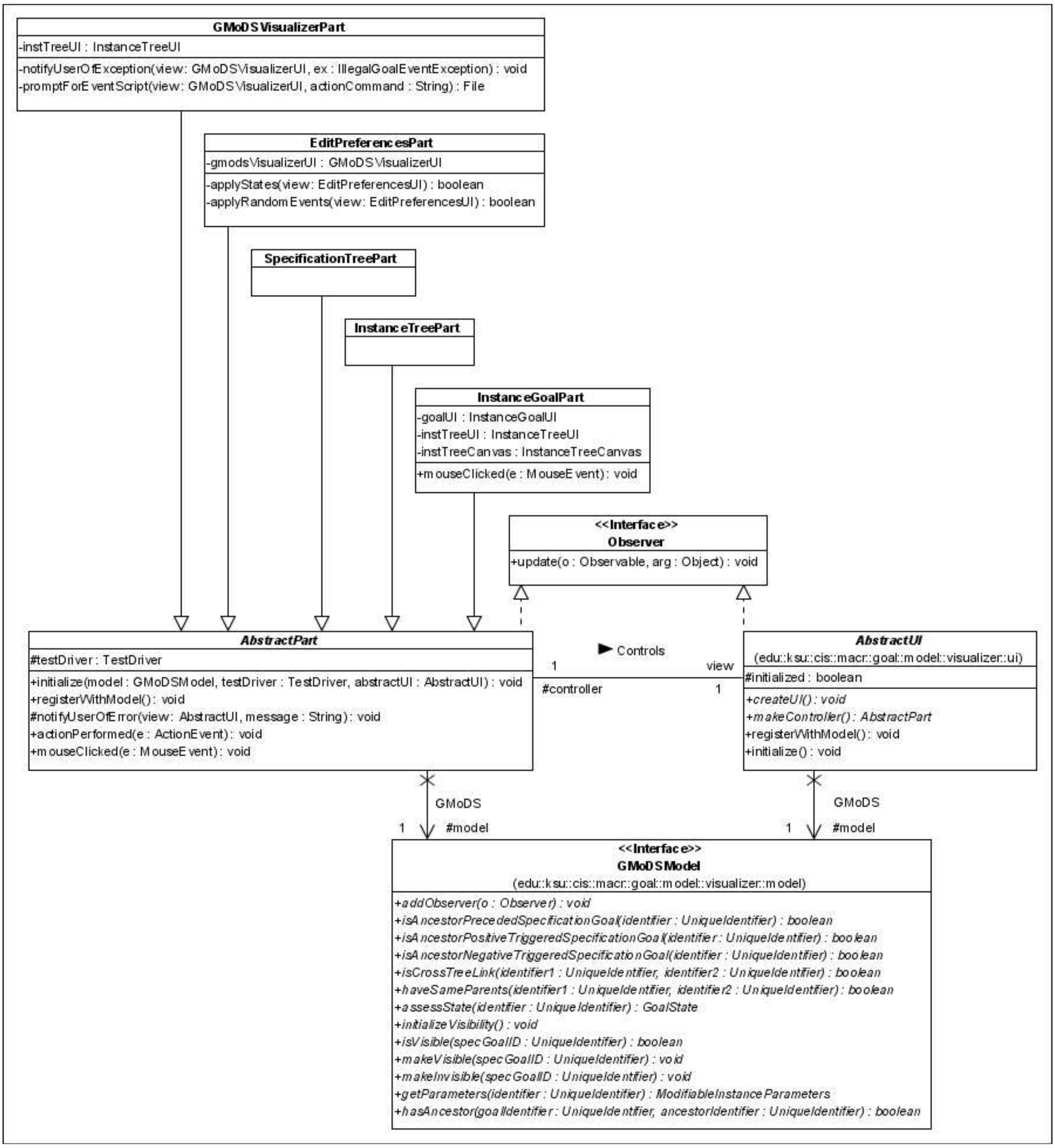

GMoDSVisualizerPart
-instTreeUI : InstanceTreeUI
-notifyUserOfException(view : GMoDSVisualizerUI, ex : IllegalGoalEventException) : void
-promptForEventScript(view : GMoDSVisualizerUI, actionCommand : String) : File
EditPreferencesPart
-gmodsVisualizerUI : GMoDSVisualizerUI
-applyStates(view : EditPreferencesUI) : boolean
-applyRandomEvents(view : EditPreferencesUI) : boolean
SpecificationTreePart
InstanceTreePart
InstanceGoalPart
-goalUI : InstanceGoalUI
-instTreeUI : InstanceTreeUI
-instTreeCanvas : InstanceTreeCanvas
+mouseClicked(e : MouseEvent) : void
<<Interface>>
Observer
+update(o : Observable, arg : Object) : void
AbstractPart
#testDriver : TestDriver
+initialize(model : GMoDSModel, testDriver : TestDriver, abstractUI : AbstractUI) : void
+registerWithModel() : void
#notifyUserOfError(view : AbstractUI, message : String) : void
+actionPerformed(e : ActionEvent) : void
+mouseClicked(e : MouseEvent) : void
Controls
1
#controller
view
1
AbstractUI
(edu::ksu::cis::macr::goal::model::visualizer::ui)
#initialized : boolean
+createUI() : void
+makeController() : AbstractPart
+registerWithModel() : void
+initialize() : void
GMoDS
1
#model
GMoDS
1
#model
<<Interface>>
GMoDSModel
(edu::ksu::cis::macr::goal::model::visualizer::model)
+addObserver(o : Observer) : void
+isAncestorPrecededSpecificationGoal(identifier : UniqueIdentifier) : boolean
+isAncestorPositiveTriggeredSpecificationGoal(identifier : UniqueIdentifier) : boolean
+isAncestorNegativeTriggeredSpecificationGoal(identifier : UniqueIdentifier) : boolean
+isCrossTreeLink(identifier1 : UniqueIdentifier, identifier2 : UniqueIdentifier) : boolean
+haveSameParents(identifier1 : UniqueIdentifier, identifier2 : UniqueIdentifier) : boolean
+assessState(identifier : UniqueIdentifier) : GoalState
+initializeVisibility() : void
+isVisible(specGoalID : UniqueIdentifier) : boolean
+makeVisible(specGoalID : UniqueIdentifier) : void
+makeInvisible(specGoalID : UniqueIdentifier) : void
+getParameters(identifier : UniqueIdentifier) : ModifiableInstanceParameters
+hasAncestor(goalIdentifier : UniqueIdentifier, ancestorIdentifier : UniqueIdentifier) : boolean

Figure 71 GMoDS Visualizer Controller Component Classes

7.2.2.5.1 GMoDS Visualizer Controller Local Module Responsibilities

Component	Responsibilities
GMoDSVisualizerPart	Control the main view and menu items.

Component	Responsibilities
EditPreferencesPart	Control the view for editing preferences.
SpecificationTreePart	Control the zooming of the view for the specification tree.
InstanceTreePart	Control the zooming of the view for the instance tree.
InstanceGoalPart	Control the view for a instance goal.

7.2.2.5.2 GMoDS Visualizer Controller Local Module Interface Specifications

Table 48 AbstractPart Interface Specifications

Respond to menu items and button clicks.	Syntax:	actionPerformed(e : ActionEvent) : void
	Pre:	none
	Post:	Necessary actions in response to menu items and button clicks have been performed.
Respond to mouse clicks.	Syntax:	mouseClicked(e : MouseEvent) : void
	Pre:	none
	Post:	Necessary actions in response to mouse clicks have been performed.

7.2.2.5.3 GMoDS Visualizer Controller Design Rationale

As described above, the Model-View-Controller architecture separates the business rules for interacting with the user away from the presentation of the interface, allowing for maximum flexibility. I used this flexibility to enforce constraints on the FlashParameters' flash cycle and period and RandomEventParameters' minimum and maximum delay time to assure that flashing will appear reasonable.

7.2.2.6 GMoDS Visualizer Controller Behavior

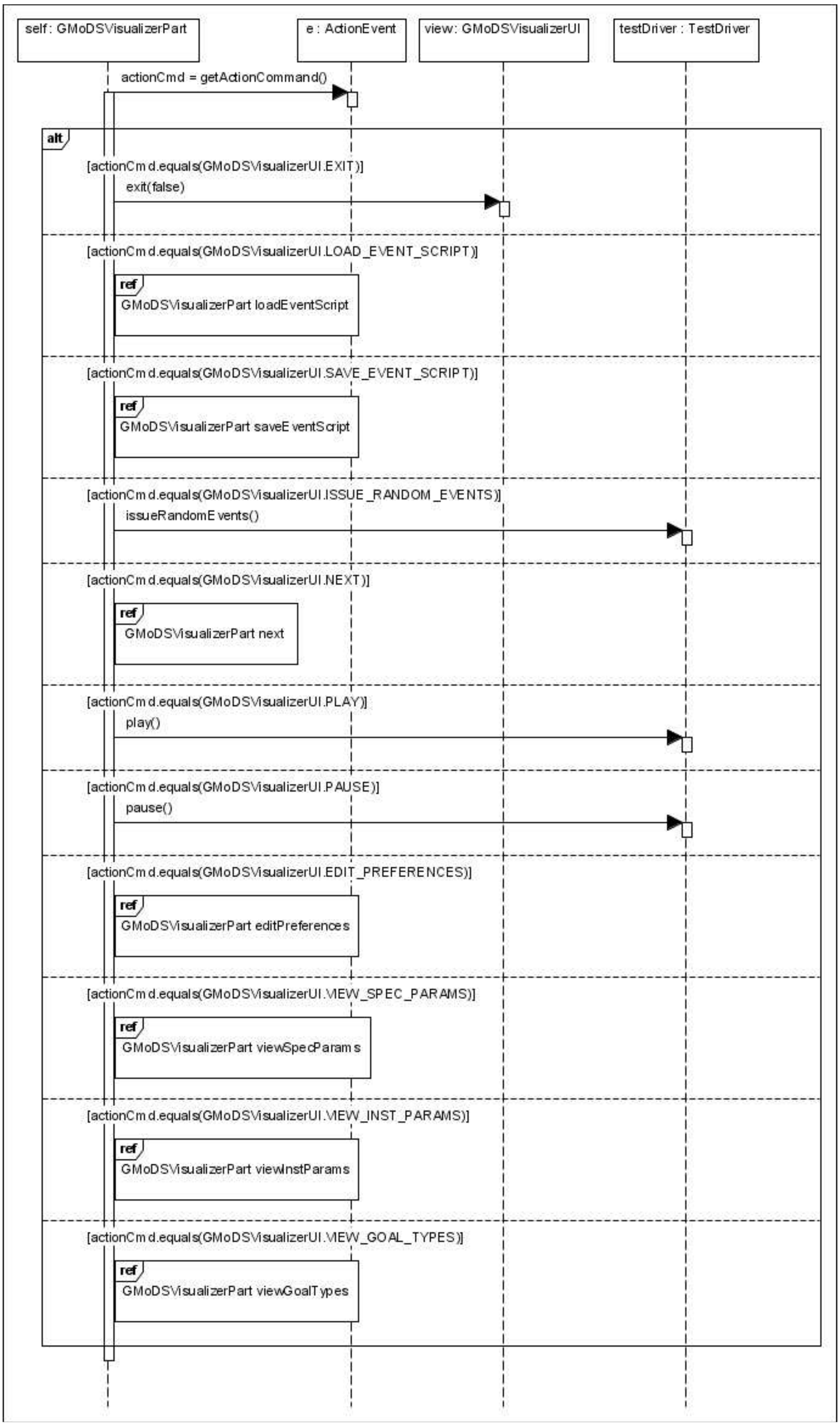

self : GMoDSVisualizerPart
e : ActionEvent
view : GMoDSVisualizerUI
testDriver : TestDriver
actionCmd = getActionCommand()
alt
[actionCmd.equals(GMoDSVisualizerUI.EXIT)]
exit(false)
[actionCmd.equals(GMoDSVisualizerUI.LOAD_EVENT_SCRIPT)]
ref
GMoDSVisualizerPart loadEventScript
[actionCmd.equals(GMoDSVisualizerUI.SAVE_EVENT_SCRIPT)]
ref
GMoDSVisualizerPart saveEventScript
[actionCmd.equals(GMoDSVisualizerUI.ISSUE_RANDOM_EVENTS)]
issueRandomEvents()
[actionCmd.equals(GMoDSVisualizerUI.NEXT)]
ref
GMoDSVisualizerPart next
[actionCmd.equals(GMoDSVisualizerUI.PLAY)]
play()
[actionCmd.equals(GMoDSVisualizerUI.PAUSE)]
pause()
[actionCmd.equals(GMoDSVisualizerUI.EDIT_PREFERENCES)]
ref
GMoDSVisualizerPart editPreferences
[actionCmd.equals(GMoDSVisualizerUI.VIEW_SPEC_PARAMS)]
ref
GMoDSVisualizerPart viewSpecParams
[actionCmd.equals(GMoDSVisualizerUI.VIEW_INST_PARAMS)]
ref
GMoDSVisualizerPart viewInstParams
[actionCmd.equals(GMoDSVisualizerUI.VIEW_GOAL_TYPES)]
ref
GMoDSVisualizerPart viewGoalTypes

Figure 72 GMoDSVisualizerPart.actionPerformed(e : ActionEvent)

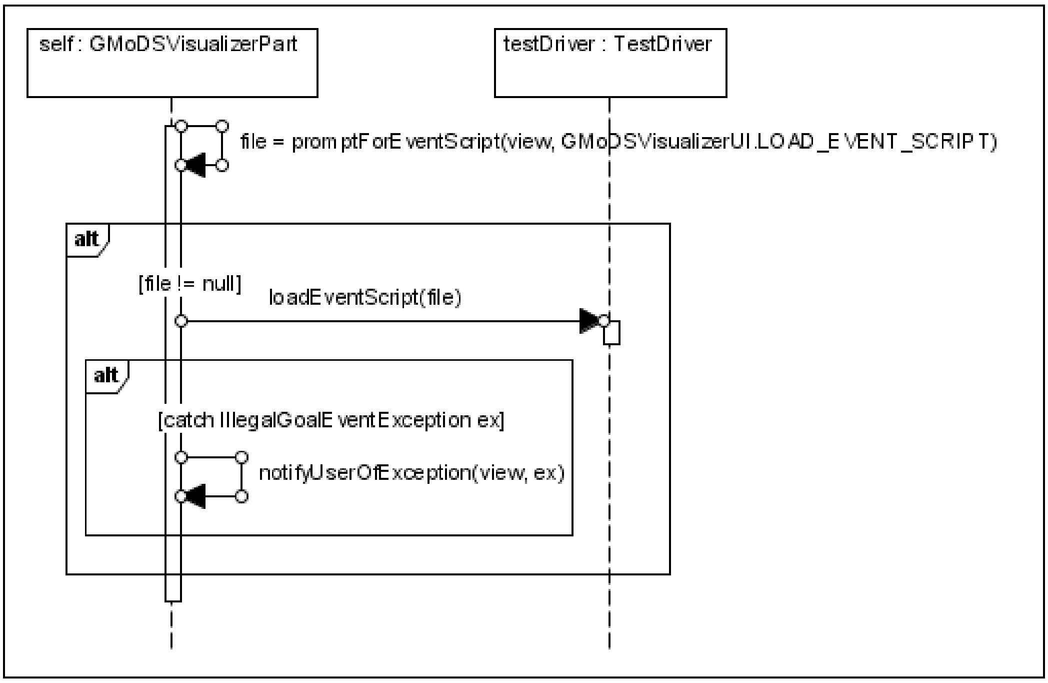

self : GMoDSVisualizerPart
testDriver : TestDriver
file = promptForEventScript(view, GMoDSVisualizerUI.LOAD_EVENT_SCRIPT)
alt
[file != null]
loadEventScript(file)
alt
[catch IllegalGoalEventException ex]
notifyUserOfException(view, ex)

Figure 73 GMoDSVisualizerPart loadEventScript

Figure 72 above shows the GMoDSVisualizerPart.actionPerformed method. Figure 73 above shows the GMoDSVisualizerPart responding to the “load event script” command. Figure 74 below shows the GMoDSVisualizerPart responding to the “save event script” command.

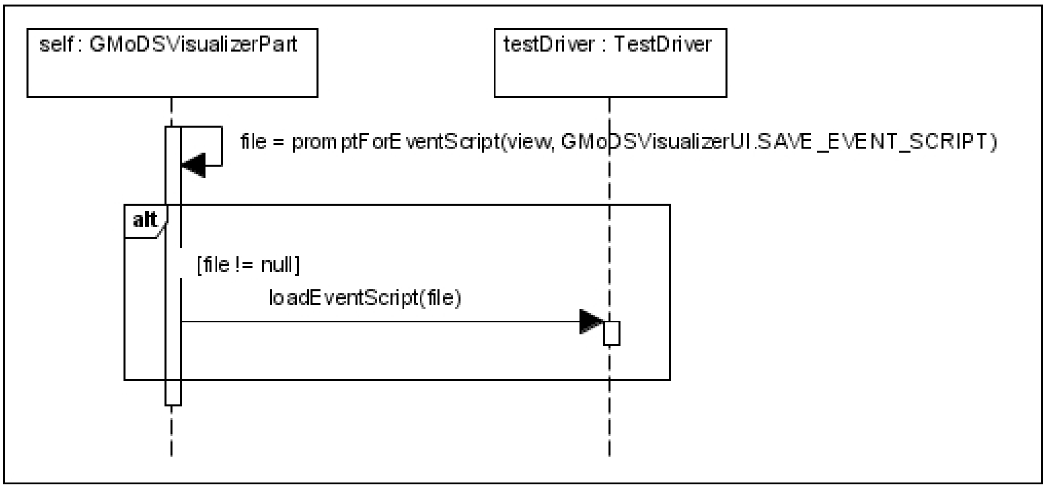

self : GMoDSVisualizerPart
testDriver : TestDriver
file = promptForEventScript(view, GMoDSVisualizerUI.SAVE_EVENT_SCRIPT)
alt
[file != null]
loadEventScript(file)

Figure 74 GMoDSVisualizerPart saveEventScript

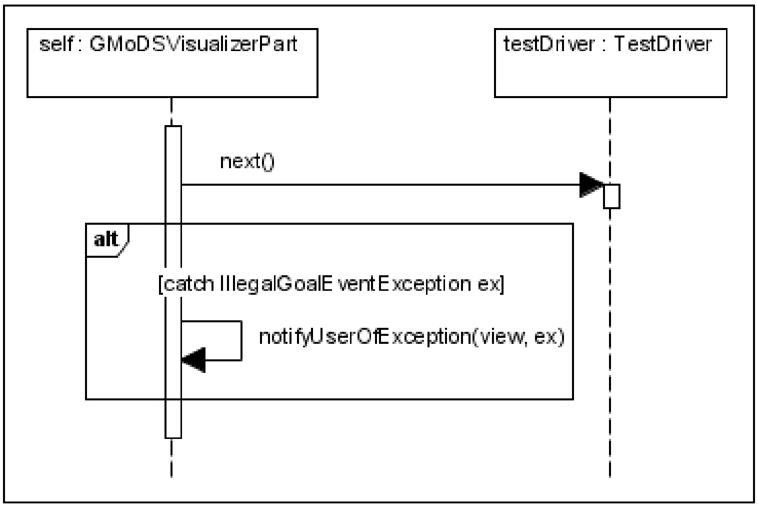

self : GMoDSVisualizerPart
testDriver : TestDriver
next()
alt
[catch IllegalGoalEventException ex]
notifyUserOfException(view, ex)

Figure 75 GMoDSVisualizer next

Figure 75 above shows the GMoDSVisualizerPart responding to the "next" command. It uses try/catch and catches IllegalGoalEventExceptions when a GoalEvent is illegal with respect to the instance tree. Figure 76 below shows the GMoDSVisualizerPart responding to the "Edit Preferences" command. Figure 77 below shows the GMoDSVisualizerPart responding to the "View | Specification Goals | Parameters" command.

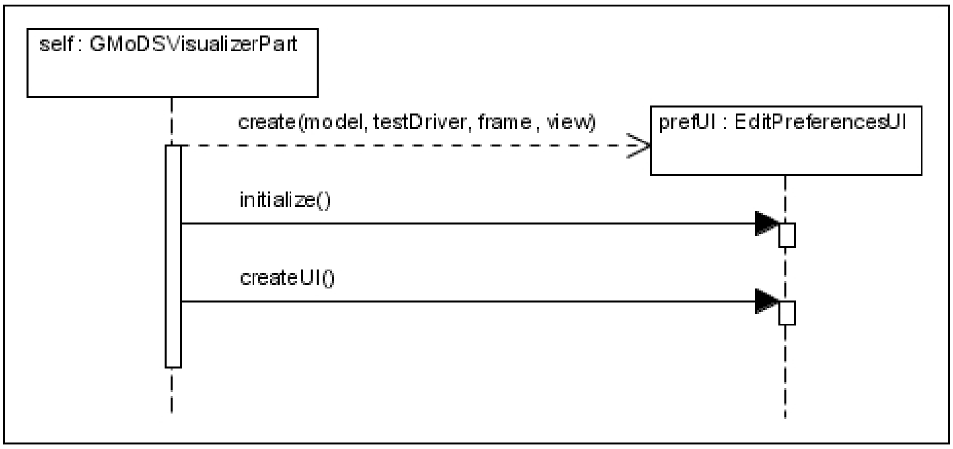

self : GMoDSVisualizerPart
create(model, testDriver, frame, view)
prefUI : EditPreferencesUI
initialize()
createUI()

Figure 76 GMoDSVisualizerPart editPreferences

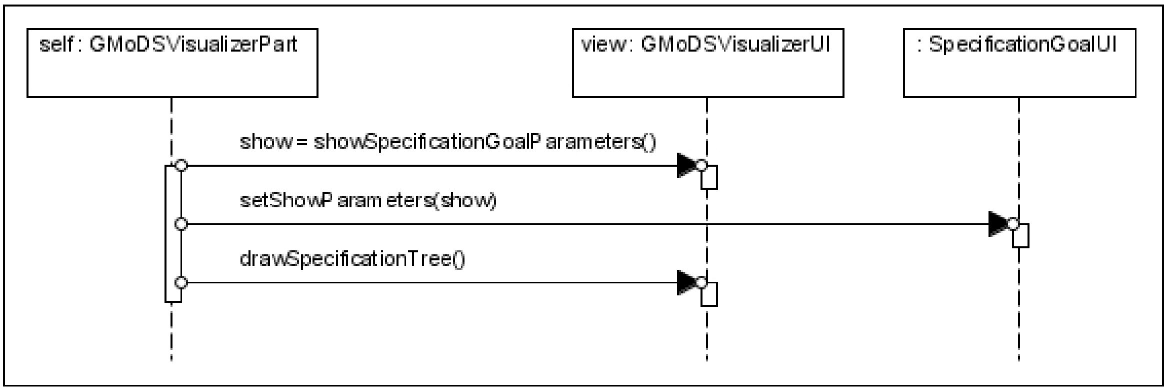


Figure 77 GMoDSVisualizerPart viewSpecParams

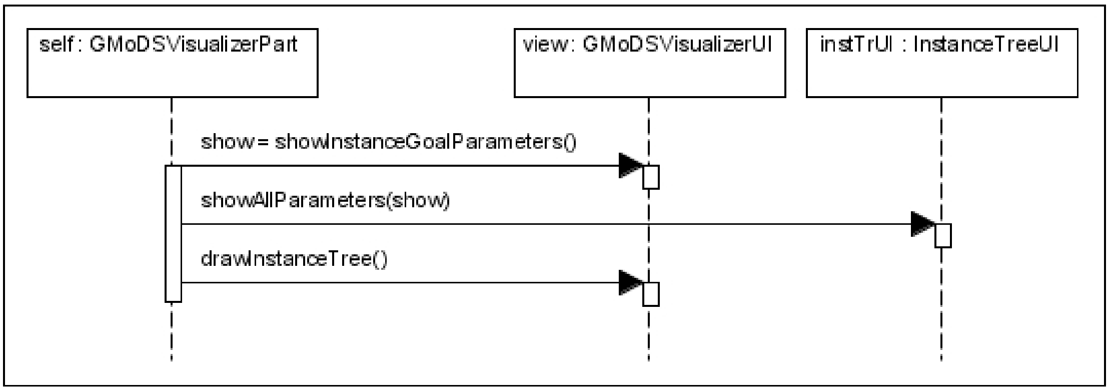

self : GMoDSVisualizerPart
view: GMoDSVisualizerUI
instTrUI : InstanceTreeUI
show= showInstanceGoalParameters()
showAllParameters(show)
drawInstanceTree()

Figure 78 GMoDSVisualizerPart viewInstParams

Figure 78 above shows the GMoDSVisualizerPart responding to the "View | Instance Goals | Parameters" command. Figure 79 below shows the GMoDSVisualizerPart responding to the "View | Instance Goals | Goal Types" command.

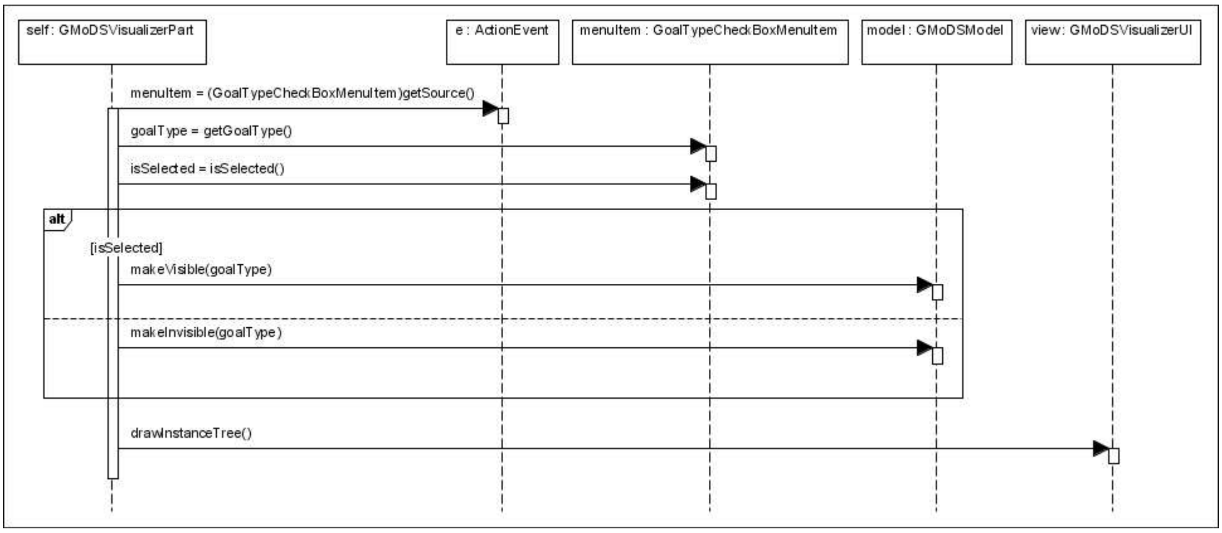


Figure 79 GMoDSVisualizerPart viewGoalTypes

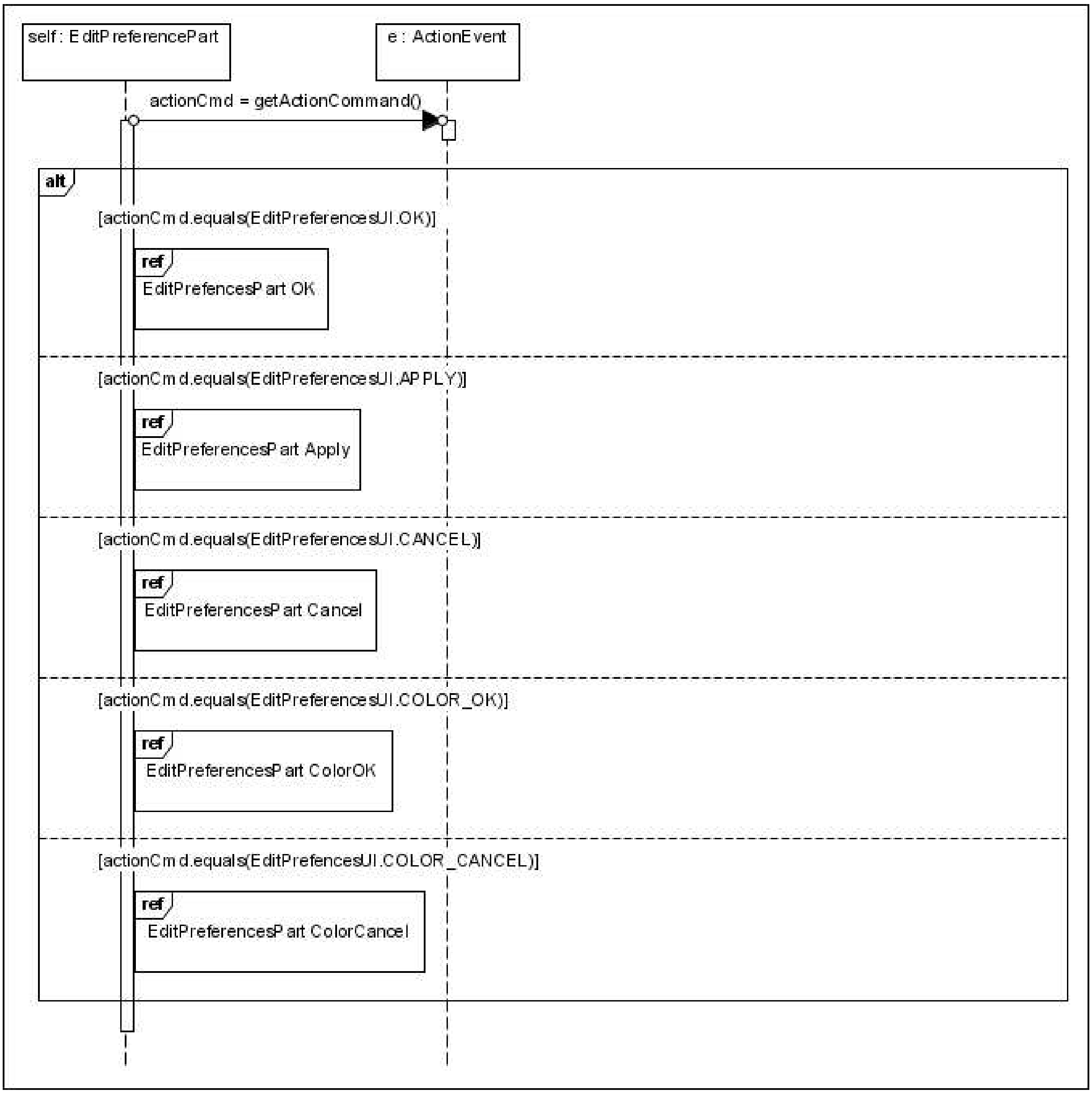

self : EditPreferencePart
e : ActionEvent
actionCmd = getActionCommand()
alt
[actionCmd.equals(EditPreferencesUI.OK)]
ref
EditPrefencesPart OK
[actionCmd.equals(EditPreferencesUI.APPLY)]
ref
EditPreferencesPart Apply
[actionCmd.equals(EditPreferencesUI.CANCEL)]
ref
EditPreferencesPart Cancel
[actionCmd.equals(EditPreferencesUI.COLOR_OK)]
ref
EditPreferencesPart ColorOK
[actionCmd.equals(EditPrefencesUI.COLOR_CANCEL)]
ref
EditPreferencesPart ColorCancel

Figure 80 EditPreferencesPart.actionPerformed(e : ActionEvent)

Figure 80 above shows the EditPrefencesPart.actionPerformed method. Figure 81 below shows the EditPreferencesPart responding to the "OK" button on the main dialog presented by its UI. The methods "applyRandomEvents" and "applyStates" enforce the business rules for user input regarding the values of the flash and random event parameters. They will return true only if the business rules are satisfied and inform the user of the violation otherwise. Figure 82 below shows the EditPreferencesPart responding to the "Apply" button on the main dialog presented by its UI. Figure 83 below shows the EditPreferencesPart responding to the "Cancel" button on the main dialog presented by its UI.

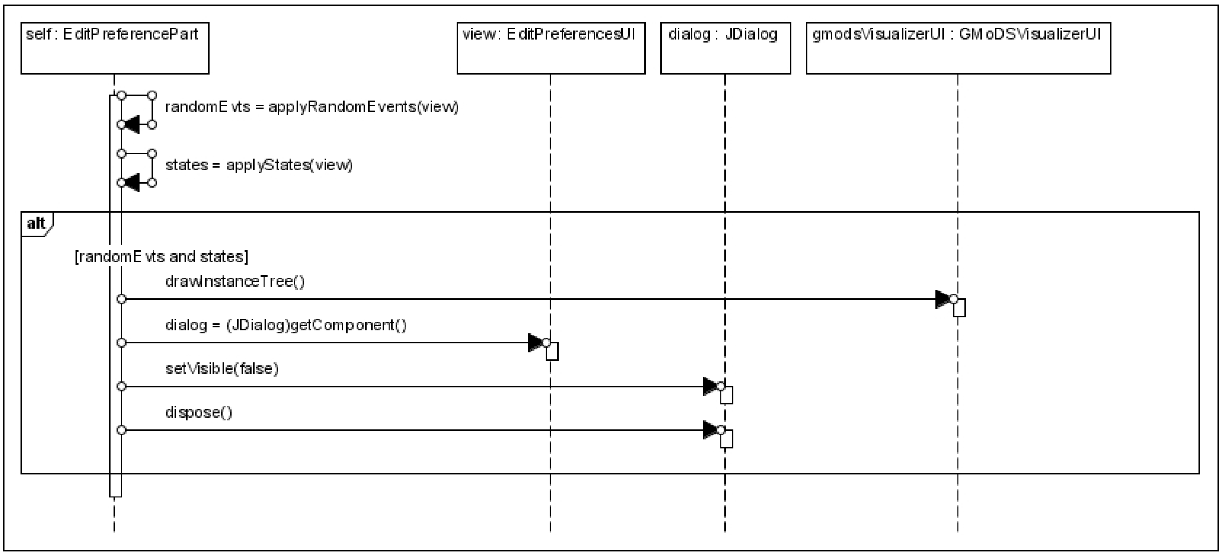

self : EditPreferencePart
view: EditPreferencesUI
dialog : JDialog
gmodsVisualizerUI : GMoDSVisualizerUI
randomEvts = applyRandomEvents(view)
states = applyStates(view)
alt
[randomEvts and states]
drawInstanceTree()
dialog = (JDialog)getComponent()
setVisible(false)
dispose()

Figure 81 EditPreferencesPart OK

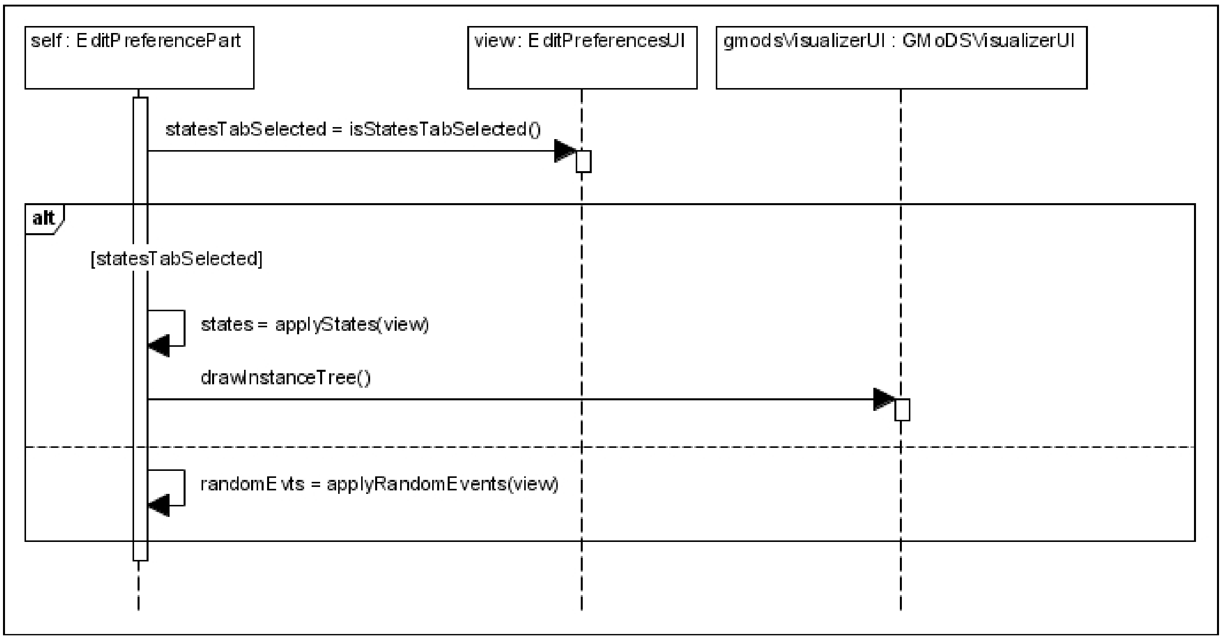

self : EditPreferencePart
view: EditPreferencesUI
gmodsVisualizerUI : GMoDSVisualizerUI
statesTabSelected = isStatesTabSelected()
alt
[statesTabSelected]
states = applyStates(view)
drawInstanceTree()
randomEvts = applyRandomEvents(view)

Figure 82 EditPreferencesPart Apply

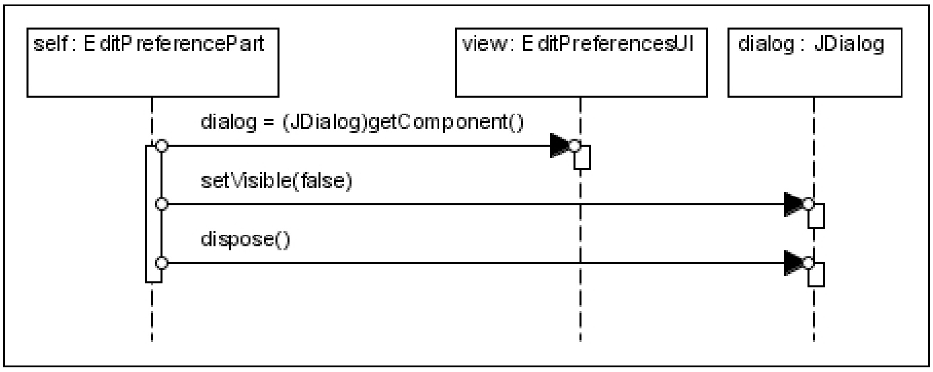


Figure 83 EditPreferencesPart Cancel

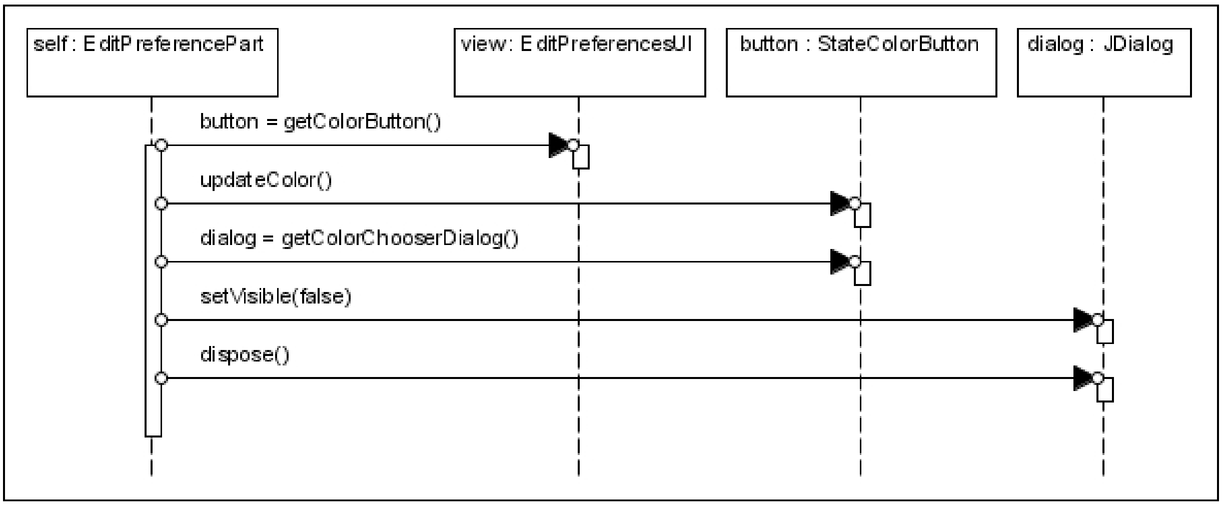

self : EditPreferencePart
view: EditPreferencesUI
button : StateColorButton
dialog : JDialog
button = getColorButton()
updateColor()
dialog = getColorChooserDialog()
setVisible(false)
dispose()

Figure 84 EditPreferencesPart ColorOK

Figure 84 above shows the EditPreferencesPart responding to the “OK” button on the color chooser dialog presented by its UI. Figure 85 below shows the EditPreferencesPart responding to the “Cancel” button on the color chooser dialog presented by its UI.

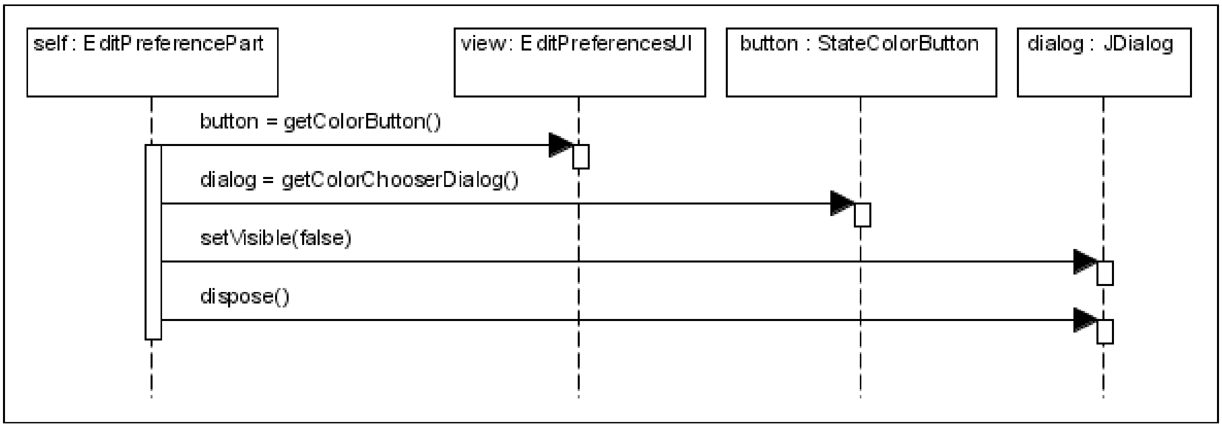

self : EditPreferencePart
view: EditPreferencesUI
button : StateColorButton
dialog : JDialog
button = getColorButton()
dialog = getColorChooserDialog()
setVisible(false)
dispose()

Figure 85 EditPreferencesPart ColorCancel

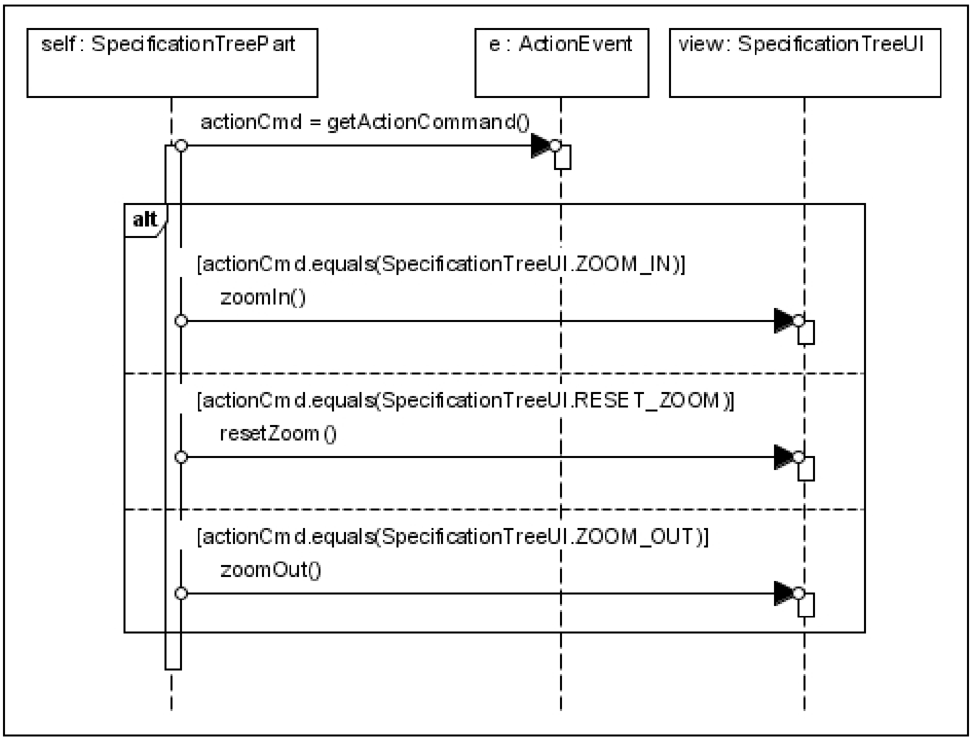

self : SpecificationTreePart
e : ActionEvent
view: SpecificationTreeUI
actionCmd = getActionCommand()
alt
[actionCmd.equals(SpecificationTreeUI.ZOOM_IN)]
zoomIn()
[actionCmd.equals(SpecificationTreeUI.RESET_ZOOM)]
resetZoom ()
[actionCmd.equals(SpecificationTreeUI.ZOOM_OUT)]
zoomOut()

Figure 86 SpecificationTreePart.actionPerformed(e : ActionEvent)

Figure 86 above shows the SpecificationTreePart.actionPerformed method. Figure 87 below shows the InstanceTreePart.actionPerformed method.

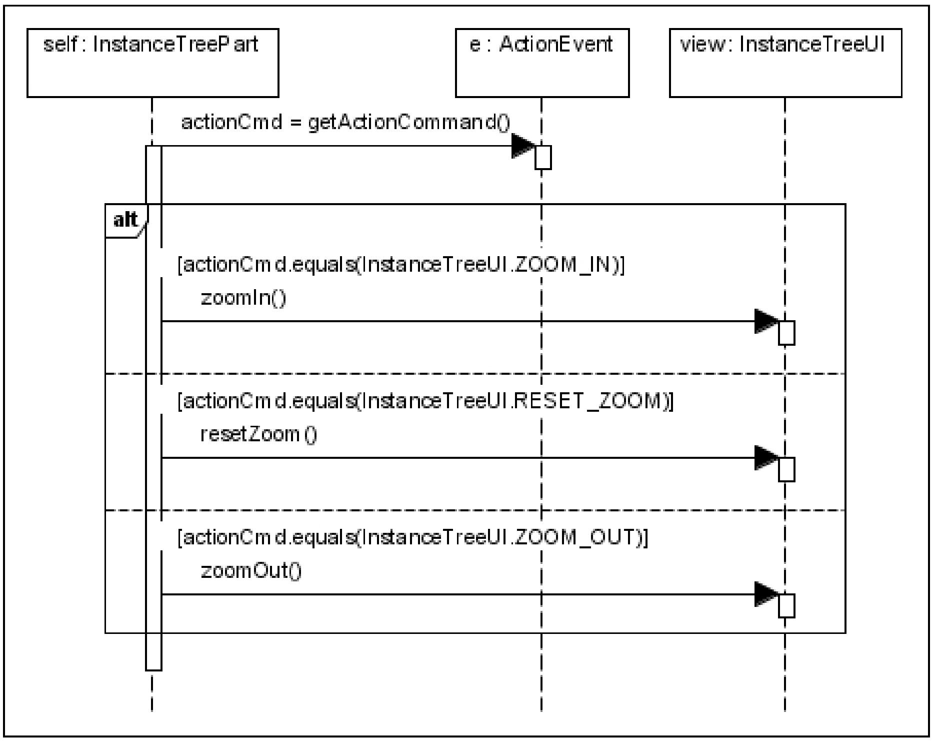

self : InstanceTreePart
e : ActionEvent
view: InstanceTreeUI
actionCmd = getActionCommand()
alt
[actionCmd.equals(InstanceTreeUI.ZOOM_IN)]
zoomIn()
[actionCmd.equals(InstanceTreeUI.RESET_ZOOM)]
resetZoom ()
[actionCmd.equals(InstanceTreeUI.ZOOM_OUT)]
zoomOut()

Figure 87 InstanceTreePart.actionPerformed(e : ActionEvent)

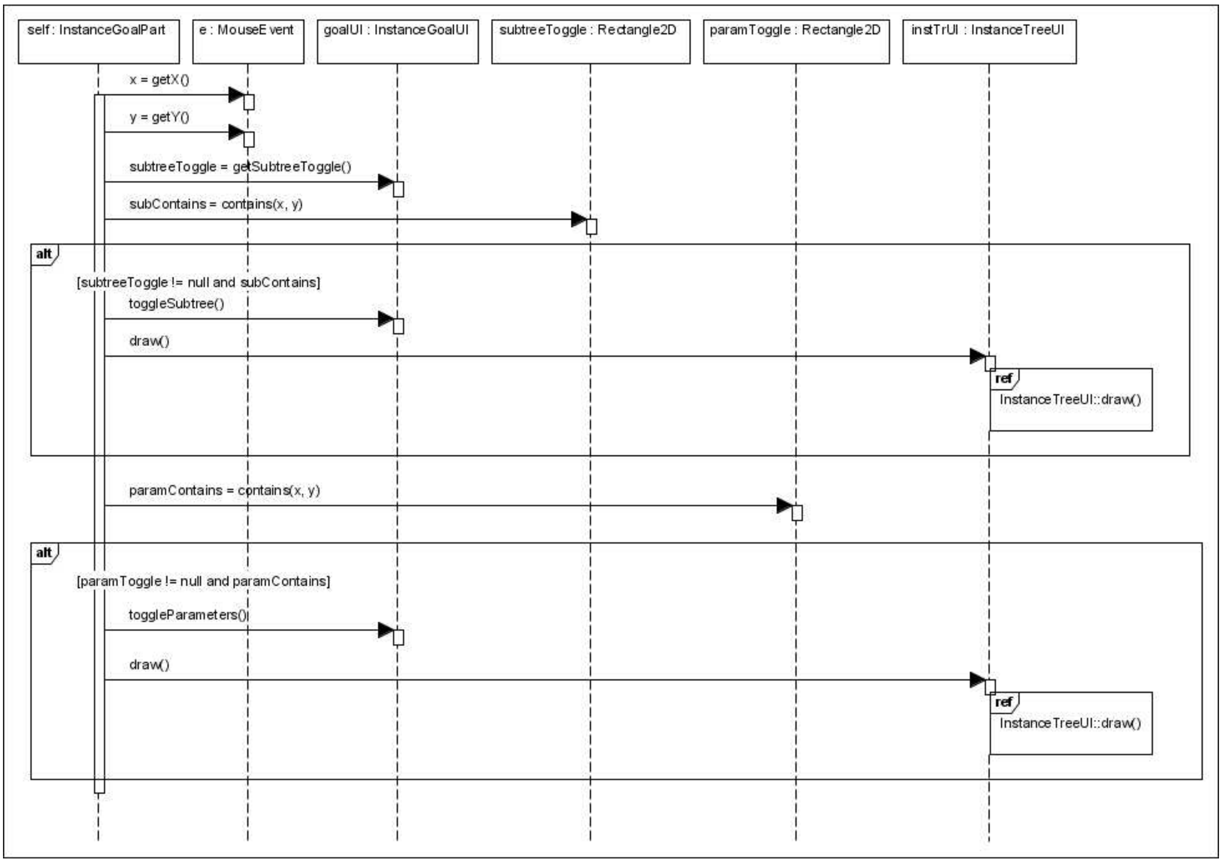

self : InstanceGoalPart
e : MouseEvent
goalUI : InstanceGoalUI
subtreeToggle : Rectangle2D
paramToggle : Rectangle2D
instTrUI : InstanceTreeUI
x = getX()
y = getY()
subtreeToggle = getSubtreeToggle()
subContains = contains(x, y)
alt
[subtreeToggle != null and subContains]
toggleSubtree()
draw()
ref
InstanceTreeUI::draw()
paramContains = contains(x, y)
alt
[paramToggle != null and paramContains]
toggleParameters()
draw()
ref
InstanceTreeUI::draw()

Figure 88 InstanceGoalPart.mouseClicked(e : MouseEvent)

Figure 88 above shows the InstanceGoalPart.mouseClicked method.

8 Chapter 8 Test Plan

8.1 Test Plan Identifier

GMoDS-Visualizer-TestDriver-TestPlan-2.0

8.2 Introduction

This document describes the testing to be performed on the GMoDS Visualizer and Test Driver components. The GMoDS Visualizer component allows visualization of the specification tree and instance tree goals within the Goal Model for Dynamic Systems (GMoDS). The GMoDS Test Driver is a component that allows scripted events (from a file or generated randomly) to be send to GMoDS to test the GMoDS Visualizer. This testing will be performed in accordance with the Project Plan 2.0 and Software Quality Assurance Plan 1.0 available at http://people.cis.ksu.edu/~mfraka/FrakaMSE.html.

8.3 Test Items

The requirement specifications for all features of each item to be tested can be found in Vision Document 2.0 at http://people.cis.ksu.edu/~mfraka/FrakaMSE.html. The architectural design and formal specification for these items can be found at the same URL.

The following items will be tested.

- GMoDS Test Driver
  - GMoDSTestDriverImpl
  - EventScriptImpl
  - RandomEventScriptImpl
  - GoalEventImpl

- GMoDS Visualizer
  - GMoDSModelImpl
  - GMoDSVisualizerUI
  - AbstractUI
  - AbstractCanvas
  - SpecificationTreeUI
  - SpecificationTreeCanvas
  - SpecificationGoalUI
  - InstanceTreeUI
  - InstanceTreeCanvas
  - InstanceGoalUI
  - AbstractRelationUI
  - AbstractTriggerUI
  - PrecedesRelationUI
  - PositiveTriggerUI
  - NegativeTriggerUI
  - FlashDaemon
  - AbstractPart

- GMoDSVisualizerPart
- SpecificationTreePart
- InstanceTreePart
- InstanceGoalPart

8.4 Features to be tested

This section lists the system requirements that will be tested for the GMoDS Test Driver and GMoDS Visualizer. For each component each feature to be tested is uniquely identified in its own sub-section and associated with the specific system requirement(s) that define the feature. This document uses these tested feature identifiers as a convenient cross-reference to avoid repeating system requirement details.

8.4.1 GMoDS Test Driver

8.4.1.1 TF.GTD-1.1

SR.GTD-1.1 - the [GMoDS Visualizer on behalf of the] GMoDS Test Driver shall prompt the user for a goal event script [etc.].

8.4.1.2 TF.GTD-1.2

SR.GTD-1.2 - the GMoDS Test Driver shall parse the goal event script to generate goal events.

8.4.1.2.1 TF.GTD-1.2.1

SR.GTD-1.2.1 - the GMoDS Test Driver shall log errors and drop invalid goal events from the script. In addition, the [GMoDS Visualizer on behalf of the] GMoDS Test Driver shall visually inform the user of these errors.

8.4.1.2.2 TF.GTD-1.2.2

SR.GTD-1.2.2 - the GMoDS Test Driver shall support a scripted events language with the following event types: ACHIEVED, FAILED, and MODIFIED events for each active instance goal, and positive and negative trigger events defined by the specification goal corresponding to any active instance goal.

8.4.1.2.3 TF.GTD-1.2.3

SR.GTD-1.2.3 - the GMoDS Test Driver Event Script Language (GTD-ESL) shall include the XML elements and attributes defined in all sub-requirements labeled SR.GTD-1.2.3.X where X ranges from 1 to 8.

8.4.1.3 TF.GTD-1.5

SR.GTD-1.5 - the GMoDS Test Driver shall issue each goal event defined in the event script to GMoDS after the specified delay time (milliseconds) relative to the previously issued goal event (automatic mode) or after the user selects “Next” (manual mode).

8.4.1.4 TF.GTD-1.6

SR.GTD-1.6 - upon initialization of the GMoDS Test Driver in this use case, the GMoDS Test Driver shall enter manual mode and await user interaction.

8.4.1.4.1 TF.GTD-1.6.1

SR.GTD-1.6.1 - If the user clicks “Play” in manual mode, the GMoDS Test Driver enters automatic mode and begins to execute each event [etc.].

8.4.1.4.2 TF.GTD-1.6.2

SR.GTD-1.6.2 - if the user clicks “Next” in manual mode, the GMoDS Test Driver issues the next unexecuted goal event and waits for the next user interaction [etc.].

8.4.1.4.3 TF.GTD-1.6.3

SR.GTD-1.6.3 - if the user clicks “Pause” in automatic mode, the GMoDS Test Driver enters manual mode and waits for the next user interaction.

8.4.1.4.4 TF.GTD-1.6.4

SR.GTD-1.6.4 - if there are no more pre-defined events remaining or the specified number of random events have been issued, the GMoDS Test Driver disables the “Play” and “Next” controls.

8.4.1.4.5 TF.GTD-2.1.2

SR.GTD.2.1.2 - the GMoDS Test Driver may be configured with the minimum and maximum string lengths for randomly generated strings. The system shall default to a minimum string length of 1 and a maximum string length of 10.

8.4.1.4.6 TF.GTD-2.1.3

SR.GTD.2.1.3 - the GMoDS Test Driver may be configured with the minimum and maximum delay time in milliseconds between randomly issued goal events. The system shall default to a minimum delay time of 100 milliseconds and maximum delay time of 5000 milliseconds. The system shall not accept a minimum delay time of less than 1 millisecond.

8.4.1.4.7 TF.GTD-2.1.4

SR.GTD.2.1.4 - the GMoDS Test Driver may be configured with the number of random goal events to issue. The system will default to 25 random goal events to issue.

8.4.1.5 TF.GTD-2.2

SR.GTD-2.2 - the GMoDS Test Driver shall incrementally issue random goal events based on the current active instance goals.

8.4.1.6 TF.GTD-2.3

SR.GTD-2.3 - the GMoDS Test Driver shall keep a history of randomly-generated goal events to form the current event script being executed.

8.4.1.7 TF.GTD-3.1

SR.GTD-3.1 - the GMoDS Test Driver shall provide a “Save Script” menu item that will cause the GMoDS Test Driver to save the currently executing goal event script to a file.

8.4.1.8 TF.GTD-3.2

SR.GTD-3.2 - the [GMoDS Visualizer on behalf of the] GMoDS Test Driver shall allow the user to specify the file to contain the saved script.

8.4.1.8.1 TF.GTD-3.2.1

SR.GTD-3.2.1 - if the user selects a file that exists, the [GMoDS Visualizer on behalf of the] GMoDS Test driver shall ask for confirmation that it should overwrite that file.

8.4.1.8.2 TF.GTD-3.2.2

SR.GTD-3.2.2 - if the user selects a file name that does not exist or confirms the overwrite-operation, the GMoDS Test Driver shall save the current goal event script to the file.

8.4.2 GMoDS Visualizer

8.4.2.1 TF.GV-1.1

SR.GV-1.1 - the system shall display the specification goal tree as a graphical tree using minimum white space padding between adjacent tree elements [etc.].

8.4.2.2 TF.GV-1.2

SR.GV-1.2 - the system shall display the string name of all specification goals, parent/child connectives («and» and «or»), trigger events, negative trigger events, and precedes relations («precedes»).

8.4.2.3 TF.GV-1.3

SR.GV-1.3 the system shall use the current “Specification Tree Show/Hide Parameters” setting to decide whether to display the parameter name for goals or events.

8.4.2.4 TF.GV-1.4

SR.GV-1.4 - the system shall show all parent/child, precedes, positive trigger, and negative trigger relations as lines connecting two specification goals.

8.4.2.5 TF.GV-1.5

SR.GV-1.5 - the lines connecting the source specification goal to the destination specification goal for positive trigger, negative trigger, and precedes relations shall have an arrow head pointing to the destination goal.

8.4.2.6 TF.GV-1.6

SR.GV-1.6 - parent/child, precedes, and trigger relation lines shall be solid.

8.4.2.7 TF.GV-1.7

SR.GV-1.7 - negative trigger relation lines shall be dashed.

8.4.2.8 TF.GV-1.8

SR.GV-1.8 - the system shall separate specification goal names from parameters using a horizontal line if parameters are displayed. If parameters are not displayed no such horizontal line shall be shown.

8.4.2.9 TF.GV-1.9

SR.GV-1.9 - the system shall show for each specification goal each parameter name on its own single separate line.

8.4.2.10 TF.GV-1.10

SR.GV-1.10 - the system shall show all event parameters on a single line between the opening parenthesis and closing parenthesis separated by a comma. The final parameter shall be followed by the closing parenthesis and no comma.

8.4.2.11 TF.GV-1.11

SR.GV-1.11 - parent/child relation lines shall not intersect with each other.

8.4.2.12 TF.GV-1.12

SR.GV-1.12 - the system shall minimize the number of intersections between precedes, positive trigger, negative trigger, and parent/child relation lines.

8.4.2.13 TF.GV-1.13

SR.GV-1.13 - the system shall not allow any lines to intersect goal rectangles.

8.4.2.14 TF.GV-1.14

SR.GV-1.14 the system shall provide scrolling and zooming of the specification goal tree view.

8.4.2.15 TF.GV-2.1

SR.GV-2.1 - the system shall display the instance goal tree as a graphical tree using minimum white space padding between adjacent tree elements [etc.].

8.4.2.16 TF.GV-2.2

SR.GV-2.2 - the system shall display the instance goal name for each instance goal.

8.4.2.17 TF.GV-2.3

SR.GV-2.3 - the system shall display a collapse/expand toggle rectangle, if the instance goal has children, centered on the lower edge of the instance goal. An instance goal displaying its children will display the character "-" in the collapse/expand toggle. An instance goal hiding its children will display "+" in the collapse/expand toggle.

8.4.2.18 TF.GV-2.4

SR.GV-2.4 - the system shall display a show/hide parameter toggle rectangle, if the instance goal has parameters, centered on the left edge of the instance goal. An instance goal showing its parameters will display the character “H” in the show/hide parameter toggle. An instance goal hiding its parameters will display the character “S” in the show/hide parameter toggle.

8.4.2.19 TF.GV-2.5

SR.GV-2.5 - the system shall connect each parent instance goal to one of its child instance goals using a line with an arrow pointing to the child, whose source is the collapse/expand toggle control on the parent instance goal. The arrow head shall be centered on the top edge of the child instance goal.

8.4.2.20 TF.GV-2.6

SR.GV-2.6 - the system shall separate instance goal names from parameters using a horizontal line if parameters are displayed. If parameters are not displayed no such horizontal line shall be shown.

8.4.2.21 TF.GV-2.7

SR.GV-2.7 - the system shall show each instance goal parameter, parameter value, and parameter value origin combination on a single line separated by a space, a semi-colon, and another space. One line will be used for each combination of instance goal parameter, parameter value, and parameters value origin.

8.4.2.22 TF.GV-2.8

SR.GV-2.8 - the system shall abbreviate the parameter value origin values as I (inherited), T (trigger), and M (modification).

8.4.2.23 TF.GV-2.9

SR.GV-2.9 - the system shall provide scrolling and zooming of the instance goal tree view.

8.4.2.24 TF.GV-2.10

SR.GV-2.10 - the system shall allow the user to specify that instance goals of particular specification goals be shown or hidden.

8.4.2.25 TF.GV-3.1

SR.GV-3.1 - the system shall flash all instance goals for which it has received a change for a pre-defined period.

8.4.2.26 TF.GV-3.2

SR.GV-3.2 - the default flashing period shall be 2 seconds. The default flashing cycle shall be 0.5 second. Both the flashing period and flashing cycle shall be editable in manual mode.

8.4.2.27 TF.GV-3.3

SR.GV-3.3 - the system shall flash an instance goal by changing its background and foreground from its state color to its defined flash color and back once every flashing cycle [etc.].

8.4.2.28 TF.GV-4.1

SR.GV-4.1 - the system shall show or hide all specification goal and event parameters as specified by the user.

8.4.2.29 TF.GV-5.1

SR.GV-5.1 - the system shall show or hide all instance goal parameters as specified by the user.

8.4.2.30 TF.GV-6.1

SR.GV-6.1 - the system shall toggle the display of parameter names, value, and value origins for the specific instance goal whose parameter display toggle control has been clicked.

8.4.2.31 TF.GV-7.1

SR.GV-7.1 - the system shall collapse the specific instance goal sub-tree hiding all descendant goals if the user clicks on the collapse toggle control of that instance goal.

8.4.2.32 TF.GV-7.2

SR.GV-7.2 - the system shall expand the specific instance goal sub-tree showing all descendant goals whose parent goal has not been collapsed, if the user clicks on the expand toggle control of that instance goal.

8.4.2.33 TF.GV-7.3

SR.GV-7.3 - the system shall not change the expand/collapse state of any instance goal whose expand/collapse control was not directly clicked.

8.5 Features not to be tested

8.5.1 GMoDS Test Driver

- SR.GTD-1.3 - the GMoDS Test Driver shall cause GMoDS to populate its specification goal tree.
- SR.GTD-1.4 - the GMoDS Test Driver shall cause GMoDS to initialize its instance goal tree.
- SR.GTD.2.1.1 - the GMoDS Test Driver shall treat all parameter types as if they were String.

8.5.2 GMoDS Visualizer

All features are to be tested as specified in 8.4.2 above.

8.6 Approach

This test plan addresses the testing of the GMoDS Visualizer and Test Driver using automated unit (white box) testing using JUnit 3.8, and manual black box testing. The GMoDS Visualizer will be manually tested while stimulated by the GMoDS Test Driver and sample client simulations.

8.6.1 GMoDS Test Driver

The GMoDS Test Driver module GoalEventImpl will be unit tested. Table 49 below lists the GMoDS Test Driver unit tested features. In addition, manual tests will exercise all tested GMoDS Test Driver features.

Table 49 GMoDS Test Driver unit tested features

Unit tested feature
TF.GTD-1.2.1

8.6.2 GMoDS Visualizer

The GMoDS Visualizer modules will not be unit tested; manual tests will exercise all features with the GMoDS Visualizer stimulated by a simulation or by the GMoDS Test Driver.

8.7 Item Pass/Fail Criteria

Tests will pass if they meet the requirements specified for the tested feature in Vision Document 2.0 and fail otherwise.

8.8 Suspension Criteria and Resumption Requirements

8.8.1 Suspension Criteria

If a manual test fails all tests for features that rely on the failed feature will be suspended. The failed test case will be entered into the test log with a description of the failure and date and time. Tested features that do not depend on the failed feature will continue.
Automated unit tests will continue in the presence of failures.

8.8.2 Resumption Requirements

Testing for a failed feature will resume once the defect causing the failure has been identified and resolved.

8.9 Test Deliverables

8.9.1 Test Log

The test log will document all test cases. The log will include the date and time of the test, the test case identifier, the pass/fail status, reasons for the failure, and the action taken to resolve the failure.

8.10 Testing Tasks

8.10.1 GMoDS Test Driver

8.10.1.1 Unit Tests

Unit tests will be created for the tested features listed in section 8.6.1, Table 49 above. Every aspect of the class listed below that lends itself to unit testing of these features will have at least one unit test method dedicated to it.

- GoalEventImpl

8.10.1.2 Manual Tests

The GMoDS Test Driver will be manually tested by having it stimulate the GMoDS Visualizer. All of the manual tests described in this section are conducted using that configuration.

8.10.1.2.1 *Test Case TC.GTD-1 – Load Event Script*

Table 50 Test Case TC.GTD-1 Load Event Script

Use Cases Tested	GTD-1 Issue Scripted Events
Features Tested	TF.GTD-1.1 TF.GTD-1.2 TF.GTD-1.2.1 TF.GTD-1.2.2 TF.GTD-1.2.3
Goal Diagrams	A goal diagram compatible with the event scripts.
Required Event Scripts (repeat procedure for each script listed here)	1. An event script file that lists a valid event of every type. 2. An event script file with events that are invalid with respect to the specification tree (fault: goal name). 3. An event script file with events that are invalid with respect to the specification tree (fault: parameter name). 4. An event script file with events that are invalid with respect to the specification tree (fault: positive trigger with missing parameter). 5. An event script file with events that are invalid with respect to the specification tree (fault: positive trigger with extra parameter). 6. An event script file with events that are invalid with respect to the specification tree (fault: modify event with missing parameter). 7. An event script file with events that are invalid with respect to the specification tree (fault: modify event with extra parameter).
Procedure	1. Click “File | Load Event Script” on visualizer menu bar. 2. Navigate to and select the desired event script file. 3. Click OK.
Expected Results For Each Required Event Script	1. Debug log records that every valid event is created successfully. 2. Debug log records an error for every invalid event and a popup window notifies the user of the same errors.

8.10.1.2.2 *Test Case TC.GTD-2 – Event Script Operation*

Table 51 Test Case TC.GTD-2 Event Script Operation

Use Cases Tested	GTD-1 Issue Scripted Events GV-3 Update Instance Tree
Features Tested	TF.GTD-1.5 TF.GTD-1.6 TF.GTD-1.6.1 TF.GTD-1.6.2 TF.GTD-1.6.3 TF.GTD-1.6.4 TF.GV-3.1 TF.GV-3.2 TF.GV-3.3
Goal Diagrams	A goal diagram compatible with the event scripts.
Required Event Scripts (repeat procedure for each script listed here)	1. An event script file that lists a valid event of every type. 2. An event script file with events that are invalid with respect to the instance tree (fault: instance goal does not exist). 3. An event script file with events that are invalid with respect to the instance tree (fault: instance goal not active for event type not MODIFIED).

	4. An event script file with events that are invalid with respect to the instance tree (fault: negative trigger with a parameter value not matching any instance goal parameter values).
Procedure	1. Click “File | Load Event Script” on visualizer menu bar. 2. Navigate to and select the desired event script file. 3. Click OK. 4. Click Play. 5. Click Pause. 6. Click Next. 7. Click Play. 8. Let script finish. 9. Repeat this test using Next only.
Expected Results For Each Required Event Script	1. Debug log records that every valid event is issued to GMoDS successfully. 2. Debug log records an error for every invalid event and a popup window notifies the user of the same errors. 3. The Test Driver stops issuing events upon Pause and enters manual mode. Examination of the debug log confirms no event is issued while paused. 4. In manual mode, events are issued only after Next is selected. 5. Selecting Play enters automatic mode. Time stamps in the debug log confirm that the Test Driver is sleeping an appropriate time between issuing events. 6. Appropriate changes to the instance tree are displayed depending on the event issued. These changes include addition and coloring of goals and flashing.

8.10.1.2.3 Test Case TC.GTD-3 – Random Event Script Operation

Table 52 Test Case TC.GTD-3 Random Event Script Operation

Use Cases Tested	GTD-2 Issue Random Events GV-3 Update Instance Tree
Features Tested	TF.GTD-2.1.2 TF.GTD-2.1.3 TF.GTD-2.1.4 TF.GTD-2.2 TF.GTD-2.3 TF.GV-3.1 TF.GV-3.2 TF.GV-3.3
Goal Diagrams	A goal diagram with at least 1 precedes relation, 1 positive trigger, 1 negative trigger, 1 “<<or>>” connective, and 1 “<<and>>” connective.
Required Event Scripts	None.
Procedure	1. Click “Issue Random Events” on visualizer toolbar. 2. Click Play. 3. Click Pause. 4. Click Next. 5. Click Play. 6. Let script finish. 7. Repeat this test using Next only. 8. Change Random Event parameters using “Edit | Preferences” on the visualizer menu bar and repeat this testing.

Expected Results For Each Required Event Script	1. Debug log records that every event is valid and issued to GMoDS successfully. 2. The Test Driver stops issuing events upon Pause and enters manual mode. Examination of the debug log confirms no event is issued while paused. 3. In manual mode, events are issued only after Next is selected. 4. Selecting Play enters automatic mode. Time stamps in the debug log confirm that the Test Driver is sleeping an appropriate time between issuing events. 5. Appropriate changes to the instance tree are displayed depending on the event issued. These changes include addition and coloring of goals and flashing.

8.10.1.2.4 Test Case TC.GTD-4 – Save Event Script

Table 53 Test Case TC.GTD-4 - Save Event Script

Use Cases Tested	GTD-2 Issue Random Events GTD-3 Save Event Script
Features Tested	TF.GTD-2.3 TF.GTD-3.1 TF.GTD-3.2 TF.GTD-3.2.1 TF.GTD-3.2.2
Goal Diagrams	A goal diagram compatible with the event scripts.
Required Event Scripts (repeat procedure for each script listed here)	1. No inputs. 2. An event script file that lists a valid event of every type. 3. An event script file with events that are invalid with respect to the specification tree (faults: goal name, parameter name, missing parameter, extra parameter).
Procedure	1. For the no input case, click “Issue Random Events” and “Play” and allow the event script to end. Then, select “File | Save Event Script”. Restart the GMoDS Test Driver and select “File | Load Event Script” and choose the previously saved random event script file. Click “Play” and let the script end. 2. For the other input cases, load the event script and then select “File | Save Event Script” saving to a new script name. Compare the input script with the saved script.
Expected Results For Each Required Event Scripts	1. For the no input case, the two runs should have exactly the same debug logs except for actual time stamps. 2. For the event script with all valid events the saved script should match the input script. 3. For the event script with invalid events, the saved script should contain only valid events.

8.10.2 GMoDS Visualizer

8.10.2.1 Manual Tests

Manual test cases listed in this section for the GMoDS Visualizer will be performed while the Visualizer is stimulated by the GMoDS Test Driver and by at least one agent simulation if that simulation's goal diagram is compatible with the test.

8.10.2.1.1 Test Case TC.GV-1 – Display Specification Tree

Table 54 Test Case TC.GV-1 Display Specification Tree

Use Cases Tested	GV-1 Display Specification Tree
Features Tested	TF.GV-1.1 TF.GV-1.2 TF.GV-1.3 TF.GV-1.4 TF.GV-1.5 TF.GV-1.6 TF.GV-1.7 TF.GV-1.8 TF.GV-1.9 TF.GV-1.10 TF.GV-1.11 TF.GV-1.12 TF.GV-1.13
Goal Diagrams (repeat procedure for each diagram listed here)	1. A goal diagram with a goal with no parameters, a goal with at least 2 parameters, a positive trigger with at least 2 parameters, and a negative trigger with at least 2 parameters, and a precedes relation. 2. A goal diagram with non-adjacent goals connected by positive or negative triggers. 3. A goal diagram with more than one positive or negative trigger emanating from the same goal to a non-adjacent goal.
Required Event Scripts	None.
Procedure	1. Start the GMoDS Test Driver and visually examine the displayed specification tree.
Expected Results For Each Required Goal Diagram	1. No requirement from the Vision Document is violated.

8.10.2.1.2 Test Case TC.GV-2 – Display Instance Tree

Table 55 Test Case TC.GV-2 Display Instance Tree

Use Cases Tested	GV-2 Display Instance Tree
Features Tested	TF.GV-2.1 TF.GV-2.2 TF.GV-2.3 TF.GV-2.4 TF.GV-2.5 TF.GV-2.6

	TF.GV-2.7 TF.GV-2.8
Goal Diagrams (repeat procedure for each diagram listed here)	1. A goal diagram with a goal with no parameters, a goal with at least 2 parameters, a positive trigger with at least 2 parameters, and a negative trigger with at least 2 parameters, and a precedes relation. 2. A goal diagram with non-adjacent goals connected by positive or negative triggers. 3. A goal diagram with more than one positive or negative trigger emanating from the same goal to a non-adjacent goal.
Required Event Scripts	None.
Procedure	1. Start the GMoDS Test Driver and visually examine the displayed instance tree.
Expected Results For Each Required Goal Diagram	1. No requirement from the Vision Document is violated.

8.10.2.1.3 Test Case TC.GV-3 – Zooming

Table 56 Test Case TC.GV-3 Zooming

Use Cases Tested	GV-1 Display Specification Tree GV-2 Display Instance Tree
Features Tested	TF.GV-1.14 TF.GV-2.9
Goal Diagrams	1. Any goal diagram.
Required Event Scripts	1. A compatible event script.
Procedure	1. Start the GMoDS Test Driver. 2. File | Load Event Script and select the compatible script. 3. Click Play and allow the script to end. 4. Zoom in on the specification tree. 5. Zoom out on the specification tree. 6. Zoom in on the instance tree. 7. Zoom out on the instance tree.
Expected Results	1. When zooming in the affected tree gets proportionally larger in its pane and if large enough causes scroll bars to appear. 2. When zooming out the affected tree gets proportionally smaller and if small enough scroll bars disappear if previously present.

8.10.2.1.4 Test Case TC.GV-4 - Show/Hide Instance Goals of Specific Types

Table 57 Test Case TC.GV-4 Show/Hide Instance Goals of Specific Types

Use Cases Tested	GV-2 Display Instance Tree
Features Tested	TF.GV-2.10
Goal Diagrams	1. Any goal diagram.
Required Event Scripts	1. A compatible event script.

Procedure	1. Start the GMoDS Test Driver. 2. File | Load Event Script and select the compatible script. 3. Click Play and allow the script to end. 4. Select View | Instance Goal | Goal Types (uncheck a box). Click OK. 5. Select View | Instance Goal | Goal Types (recheck the box). Click OK.
Expected Results	1. When a goal type is unchecked, all instance goals of that specification goal type and their descendant instance goals are not visible. 2. When a goal type is rechecked, all instance goals of that specification goal type and their descendant instance goals are visible again.

8.10.2.1.5 Test Case TC.GV-5 - Show/Hide All Specification Goal Parameters

Table 58 Test Case TC.GV-5 Show/Hide All Specification Goal Parameters

Use Cases Tested	GV-4 Change Specification Tree View
Features Tested	TF.GV-4.1
Goal Diagrams	1. Any goal diagram with a goal and an event that have parameters.
Required Event Scripts	1. None.
Procedure	1. Start the GMoDS Test Driver. 2. Select View | Specification Goal | Parameters (uncheck the box). 3. Select View | Specification Goal | Parameters (recheck the box).
Expected Results	1. When View | Specification Goal | Parameters is unchecked, all specification goals' and events' parameters are not visible. The horizontal line separating the goal parameters from the goal name is not visible. 2. When View | Specification Goal | Parameters is rechecked, all specification goals' and events' parameters are visible. The horizontal line separating the goal parameters from the goal name is visible.

8.10.2.1.6 Test Case TC.GV-6 - Show/Hide All Instance Goal Parameters

Table 59 Test Case TC.GV-6 Show/Hide All Instance Goal Parameters

Use Cases Tested	GV-5 Change Instance Tree View
Features Tested	TF.GV-5.1
Goal Diagrams	1. Any goal diagram with a goal that has parameters.
Required Event Scripts	1. Any compatible event script with valid events.
Procedure	1. Start the GMoDS Test Driver. 2. File | Load Event Script and select the compatible script. 3. Click Play and allow the script to end. 4. Select View | Instance Goal | Parameters (uncheck the box). 5. Select View | Instance Goal | Parameters (recheck the box).
Expected Results	1. When View | Instance Goal | Parameters is unchecked, all instance goals' parameters are not visible. The horizontal line separating the goal parameters from the goal name is not visible. 2. When View | Instance Goal | Parameters is rechecked, all instance goals' parameters are visible. The horizontal line separating the goal parameters from the goal name is visible.

8.10.2.1.7 Test Case TC.GV-7 - Show/Hide Specific Instance Goal Parameters

Table 60 Test Case TC.GV-7 Show/Hide Specific Instance Goal Parameters

Use Cases Tested	GV-6 Change Instance Goal View
Features Tested	TF.GV-6.1
Goal Diagrams	1. Any goal diagram with a goal that has parameters.
Required Event Scripts	1. Any compatible event script with valid events.
Procedure	1. Start the GMoDS Test Driver. 2. File | Load Event Script and select the compatible script. 3. Click Play and allow the script to end. 4. Click the Hide toggle for an instance goal with parameters. 5. Click the Show toggle for that instance goal.
Expected Results	1. When the Hide toggle is clicked, that instance goal's parameters are not visible. The horizontal line separating the goal parameters from the goal name is not visible. 2. When the Show toggle is clicked, that instance goal's parameters are visible. The horizontal line separating the goal parameters from the goal name is visible.

8.10.2.1.8 *Test Case TC.GV-8 - Collapse/Expand Instance Goal Sub-tree*

Table 61 Test Case TC.GV-8 Collapse/Expand Instance Goal Sub-tree

Use Cases Tested	GV-7 Change Instance Sub-tree View
Features Tested	TF.GV-7.1 TF.GV-7.2 TF.GV-7.3
Goal Diagrams	1. Any goal diagram.
Required Event Scripts	1. Any compatible event script with valid events.
Procedure	1. Start the GMoDS Test Driver. 2. File | Load Event Script and select the compatible script. 3. Click Play and allow the script to end. 4. Click the Collapse toggle for an instance goal with children. 5. Click the Expand toggle for that instance goal.
Expected Results	1. When the Collapse toggle is clicked, that instance goal's descendants are not visible. 2. When the Expand toggle is clicked, that instance goal's descendants return to the same visibility as prior to the Collapse.

8.10.2.1.9 *Test Case TC.GV-9 – Change Instance Goal State Colors*

Table 62 Test case TC.GV-9 Change Instance Goal State Colors

Use Cases Tested	GV-3 Update Instance Tree
Features Tested	TF.GV-3.3
Goal Diagrams	1. A goal diagram with a goal with a positive trigger and a negative trigger, a <<precedes>> relation, and at least on <<or>> connective.
Required Event Scripts	1. Any compatible event script with valid events that will cause all possible goal states to be shown in the instance tree when executed.

Procedure	1. Start the GMoDS Test Driver. 2. Edit | Preferences and change the goal state colors as desired. Click OK. 3. File | Load Event Script and select the compatible script. 4. Click Play and allow the script to end. 5. Edit | Preferences and change normal goal state colors as desired. Click OK.
Expected Results	1. The desired colors should be used during script execution. 2. The normal desired colors should replace the previous colors upon OK being clicked. Flash colors cannot be changed since the script is not executing.

8.11 Environmental Needs

- Application environment
  - JDK 1.6 or higher available at http://www.sun.com/java.
- Development environment
  - Eclipse IDE for Java Developers 1.2.1.20090918-0703
- GMoDS Version 2
  - The GMoDS component is the GoalModel2 module in the CVS repository cvs.projects.cis.ksu.edu at the repository path /cvsroot/gmods.

8.11.1 Automated Unit Testing

The following software will be used to unit test the GMoDS Test Driver and Visualizer.

- JUnit 3.8

8.11.2 Manual Testing

8.11.2.1 GMoDS Test Driver

The GMoDS Test Driver will be manually tested by having it stimulate the GMoDS Visualizer. See 8.11.3 below.

8.11.2.2 GMoDS Visualizer

Manual test cases identified in 8.10.2.1 above for the GMoDS Visualizer will be performed while the Visualizer is stimulated by the GMoDS Test Driver and by at least one agent simulation.

8.11.3 Stimulation by GMoDS Test Driver

- GMoDS Test Driver main program launches the GMoDS Visualizer.

8.11.3.1 Stimulation by agent simulation

- The agent simulation component that populates GMoDS launches the GMoDS Visualizer.

9 Chapter 9 Assessment Evaluation

9.1 *Introduction*

This document presents the results of testing the GMoDS Visualizer and Test Driver components.

9.2 *Test Case Result Summary*

Table 63 Test Case Result Summary

Test Case ID	Test Case Title	Tested Features	Results
TC.GTD-1	Load Event Script	TF.GTD-1.1 TF.GTD-1.2 TF.GTD-1.2.1 TF.GTD-1.2.2 TF.GTD-1.2.3	Pass
TC.GTD-2	Event Script Operation	TF.GTD-1.5 TF.GTD-1.6 TF.GTD-1.6.1 TF.GTD-1.6.2 TF.GTD-1.6.3 TF.GTD-1.6.4 TF.GV-3.1 TF.GV-3.2 TF.GV-3.3	Pass
TC.GTD-3	Random Event Script Operation	TF.GTD-2.1.2 TF.GTD-2.1.3 TF.GTD-2.1.4 TF.GTD-2.2 TF.GTD-2.3 TF.GV-3.1 TF.GV-3.2 TF.GV-3.3	Pass
TC.GTD-4	Save Event Script	TF.GTD-2.3 TF.GTD-3.1 TF.GTD-3.2 TF.GTD-3.2.1 TF.GTD-3.2.2	Pass

Test Case ID	Test Case Title	Tested Features	Results
TC.GV-1	Display Specification Tree	TF.GV-1.1 TF.GV-1.2 TF.GV-1.3 TF.GV-1.4 TF.GV-1.5 TF.GV-1.6 TF.GV-1.7 TF.GV-1.8 TF.GV-1.9 TF.GV-1.10 TF.GV-1.11 TF.GV-1.12 TF.GV-1.13	Pass
TC.GV-2	Display Instance Tree	TF.GV-2.1 TF.GV-2.2 TF.GV-2.3 TF.GV-2.4 TF.GV-2.5 TF.GV-2.6 TF.GV-2.7 TF.GV-2.8	Pass
TC.GV-3	Zooming	TF.GV-1.14 TF.GV-2.9	Pass
TC.GV-4	Show/Hide Instance Goals of Specific Types	TF.GV-2.10	Pass
TC.GV-5	Show/Hide All Specification Goal Parameters	TF.GV-4.1	Pass
TC.GV-6	Show/Hide All Instance Goal Parameters	TF.GV-5.1	Pass
TC.GV-7	Show/Hide Specific Instance Goal Parameters	TF.GV-6.1	Pass
TC.GV-8	Collapse/Expand Instance Goal Sub-tree	TF.GV-7.1 TF.GV-7.2 TF.GV-7.3	Pass
TC.GV-9	Change Instance Goal State Colors	TF.GV-3.3	Pass

9.3 Test Case Result Details

Table 64 Test Case Result Details

Date	Test Case	Manual or Simulation	Input Set	Status	Reasons For Failure	Action to Resolve
3/9/2011	TC.GTD-1	M	1	PASS		
	TC.GTD-1	M	2	PASS		
	TC.GTD-1	M	3	PASS		
	TC.GTD-1	M	4	PASS		
	TC.GTD-1	M	5	PASS		
	TC.GTD-1	M	6	PASS		
	TC.GTD-1	M	7	PASS		
	TC.GTD-2	M	1	PASS		

Date	Test Case	Manual or Simulation	Input Set	Status	Reasons For Failure	Action to Resolve
	TC.GTD-2	M	2	FAIL	Uncaught IllegalGoalEventException during play	Deferred Exceptions/Add Throw and Catches
	TC.GTD-2	M	2	PASS		
	TC.GTD-2	M	3	PASS		
	TC.GTD-2	M	4	PASS		
	TC.GTD-3	M	0	PASS		
	TC.GTD-4	M	1	PASS		
	TC.GTD-4	M	2	PASS		
	TC.GTD-4	M	3	PASS		
	TC.GTD-4	M	4	PASS		
	TC.GTD-4	M	5	PASS		
	TC.GTD-4	M	6	PASS		
3/10/2011	TC.GV-1	M	1	FAIL	Rightmost specification goal cutoff in drawing	Add margins to the image on the right and bottom.
	TC.GV-1	M	1	PASS		
	TC.GV-1	M	2	PASS		
	TC.GV-1	M	3	PASS		
	TC.GV-2	M	1	PASS		
	TC.GV-2	M	2	PASS		
	TC.GV-2	M	3	PASS		
	TC.GV-3	M	1	FAIL	Specification tree right/bottom cutoff when zoomed in	Set preferred size and revalidate after zoom.
	TC.GV-3	M	1	PASS		
	TC.GV-4	M	1	PASS		
	TC.GV-5	M	1	FAIL	Specification tree relation parameters not hidden	Add flag to prevent drawing parameters.
	TC.GV-6	M	1	PASS		
	TC.GV-7	M	1	PASS		
	TC.GV-8	M	1	PASS		
	TC.GV-9	M	1	PASS		
3/11/2011	TC.GV-1	S	0	PASS		
	TC.GV-2	S	0	PASS		
	TC.GV-5	S	0	FAIL	Specification tree relation parameters not hidden	Add flag to prevent drawing parameters.
	TC.GV-5	M	1	PASS		
	TC.GV-4	S	0	PASS		
	TC.GV-8	S	0	PASS		

Date	Test Case	Manual or Simulation	Input Set	Status	Reasons For Failure	Action to Resolve
	TC.GV-3	S	0	FAIL	Specification tree right cutoff when zoomed in	Set preferred size and revalidate after zoom.
	TC.GV-9	S	0	PASS		
3/15/2011	TC.GV-6	S	0	PASS		
	TC.GV-7	S	0	PASS		

9.4 Problems Encountered

Table 65 Problems Encountered

Test Case	Failure	Action to Resolve
TC.GTD-2 – Event Script Operation	Failed to catch an IllegalGoalEventException thrown when an invalid GoalEvent is encountered during event script play.	Deferred and accumulated IllegalGoalEventExceptions while it is unsafe to throw them. Added try/catch surrounding applicable code in the play, pause, and hasNext methods. Added throw of the cumulative IllegalGoalEventException when it becomes safe to do so.
TC.GV-1 – Display Specification Tree	Rightmost specification goal cutoff in drawing.	Add margins to the image on the right and bottom.
TC.GV-3 – Zooming	Specification tree right/bottom cutoff when zoomed in.	The content of the JScrollPane, the AbstractCanvas, resets its preferred size and then calls the method “revalidate” after a zoom.
TC.GV-5 - Show/Hide All Specification Goal Parameters	Specification tree trigger parameters not hidden.	Added a flag to AbstractTriggerUI to prevent drawing parameters when hidden.

9.5 Summary

All manual and simulation test cases were performed as planned and passed. Therefore, the GMoDS Test Driver and Visualizer are ready for production use.

10 Chapter 10 User Manual

10.1 Introduction

10.2 GMoDS Visualizer

The GMoDS Visualizer can be used as an optional visualization tool with any application using GMoDS or will be used in the GMoDS Test Driver application.

10.2.1 Installation

The GMoDS Visualizer is available as an Eclipse project via the Kansas State University Multiagent & Cooperative Robotics Laboratory (MACR) CVS repositories. This section describes how to install the GMoDS Visualizer as an Eclipse project from this source and assumes you have gained permission to do so.

10.2.1.1 Check out the GMoDS Visualizer

The first step is to open the CVS Repository Exploring perspective. Figure 89 below shows how to open an “Other” perspective. Select the CVS Repository Exploring perspective as shown in Figure 90 below.

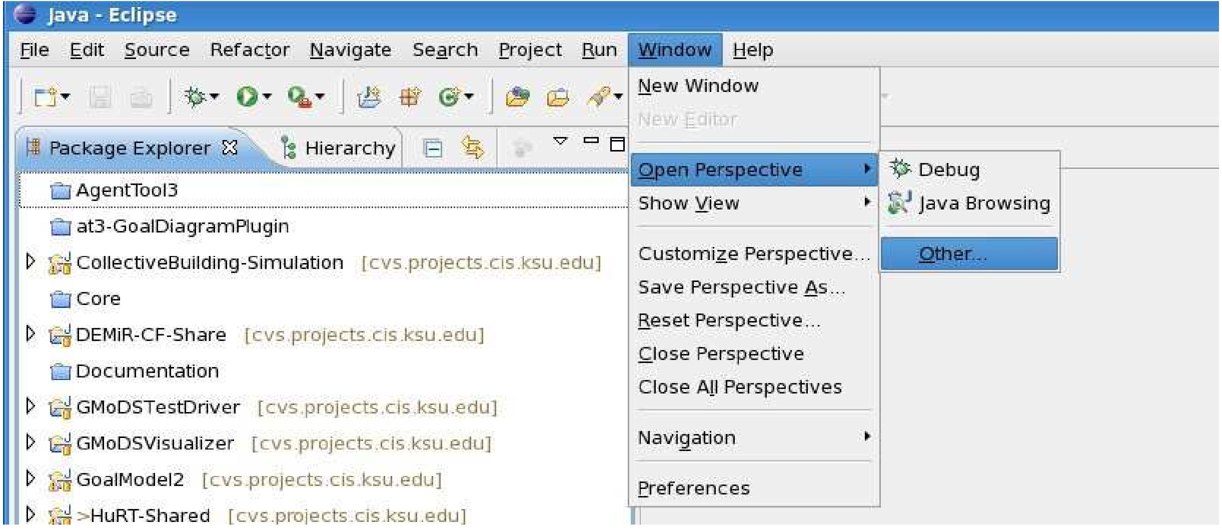


Figure 89 Window | Open Perspective | Other

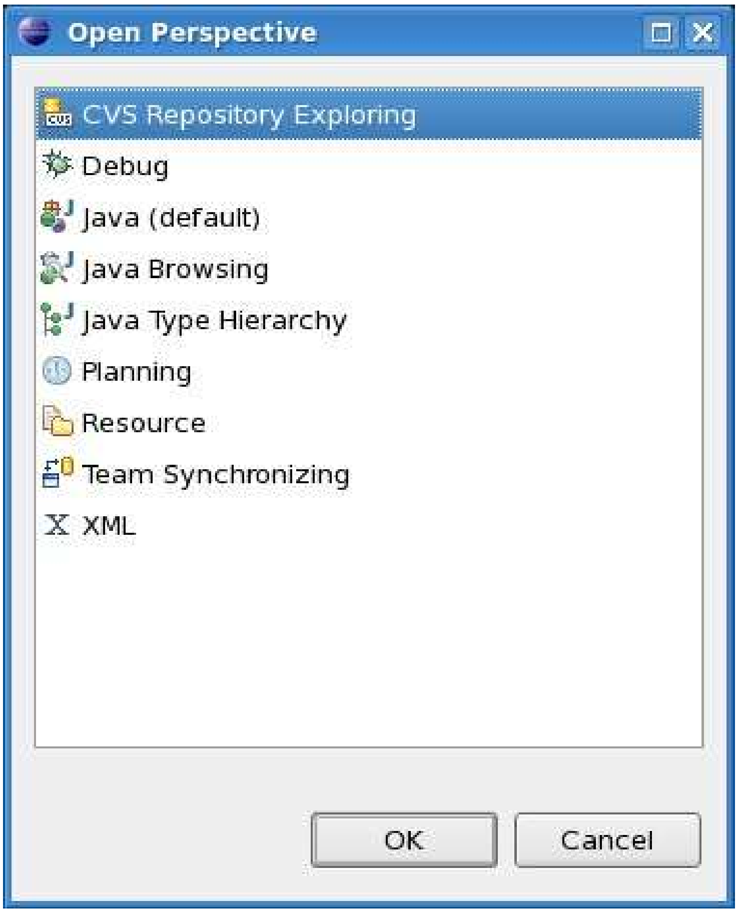
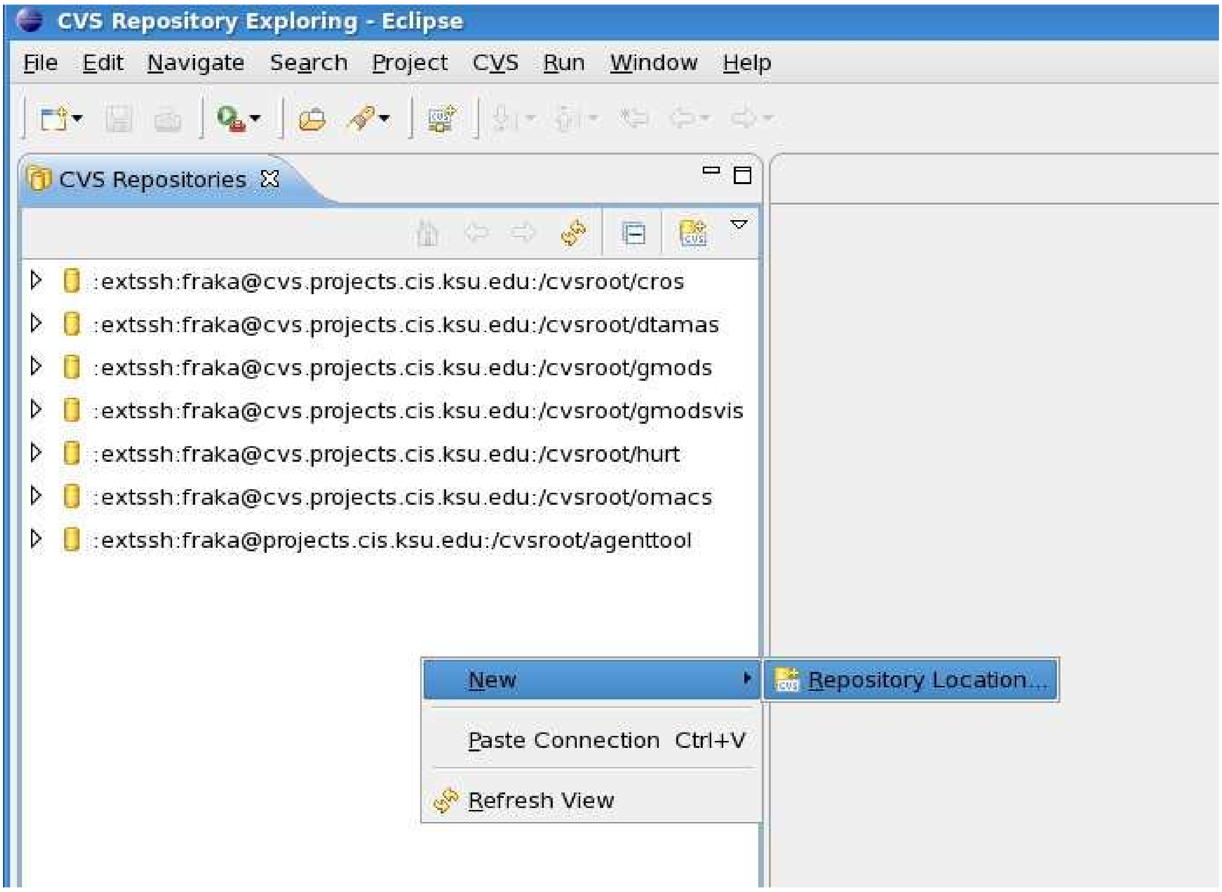


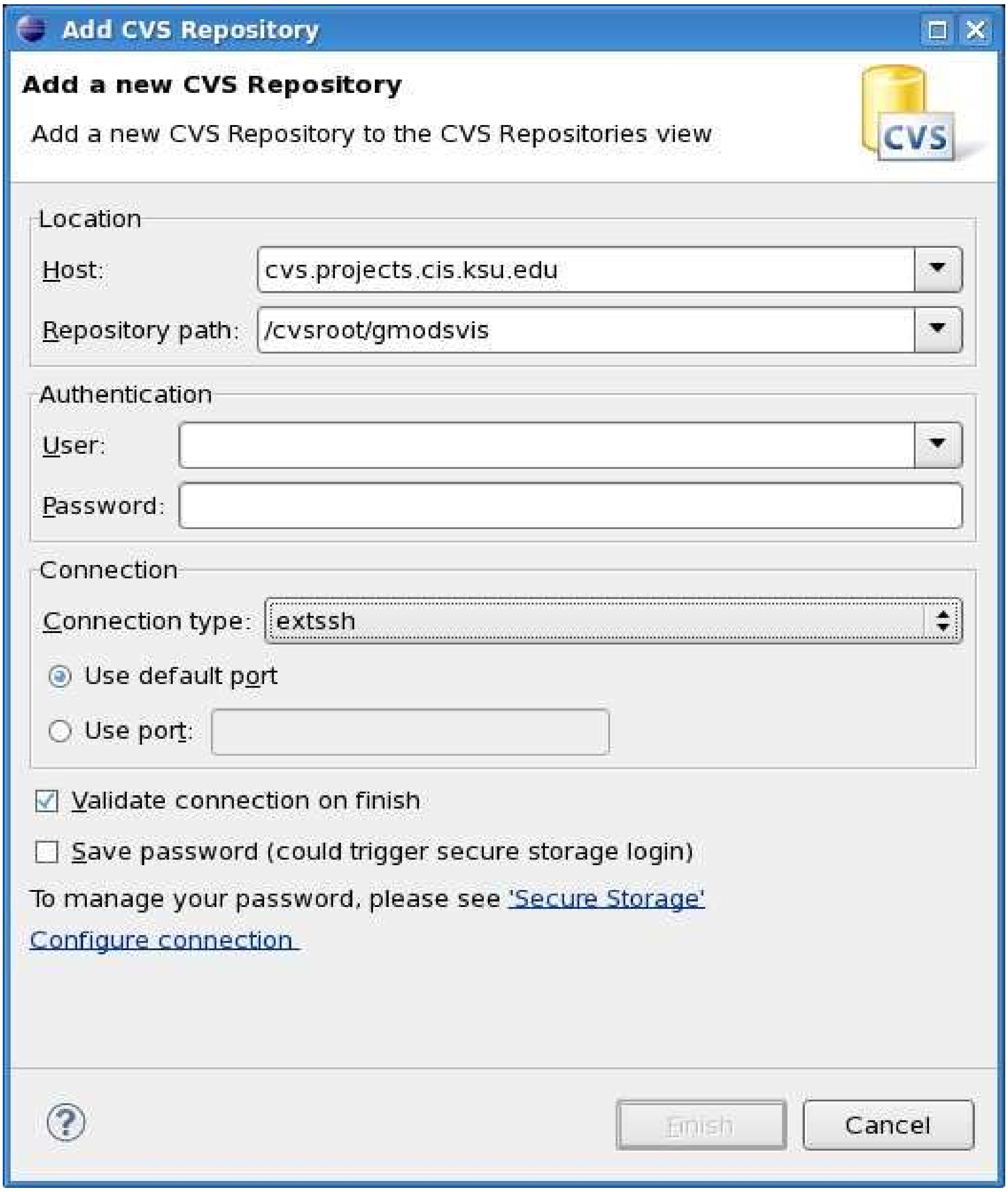
Figure 90 Open Perspective | CVS Repository Exploring


CVS Repository Exploring - Eclipse
File Edit Navigate Search Project CVS Run Window Help
CVS Repositories
New
Repository Location...
Paste Connection Ctrl+V
Refresh View

:extssh:fraka@cvs.projects.cis.ksu.edu:/cvsroot/cros
:extssh:fraka@cvs.projects.cis.ksu.edu:/cvsroot/dtamas
:extssh:fraka@cvs.projects.cis.ksu.edu:/cvsroot/gmods
:extssh:fraka@cvs.projects.cis.ksu.edu:/cvsroot/gmodsvis
:extssh:fraka@cvs.projects.cis.ksu.edu:/cvsroot/hurt
:extssh:fraka@cvs.projects.cis.ksu.edu:/cvsroot/omacs
:extssh:fraka@projects.cis.ksu.edu:/cvsroot/agenttool

Figure 91 New Repository Location

Establish a new CVS repository location by right clicking in the “CVS Repositories” tab and choosing “New | Repository Location…” as shown above in Figure 91. Add a new CVS repository location for “/cvsroot/gmodsvis” using the host “cvs.projects.cis.ksu.edu” and connection type “extssh” as shown below in Figure 92.



Add a new CVS Repository

Add a new CVS Repository to the CVS Repositories view

Location

Host: cvs.projects.cis.ksu.edu

Repository path: /cvsroot/gmodsvis

Authentication

User:

Password:

Connection

Connection type: extssh

● Use default port

○ Use port:

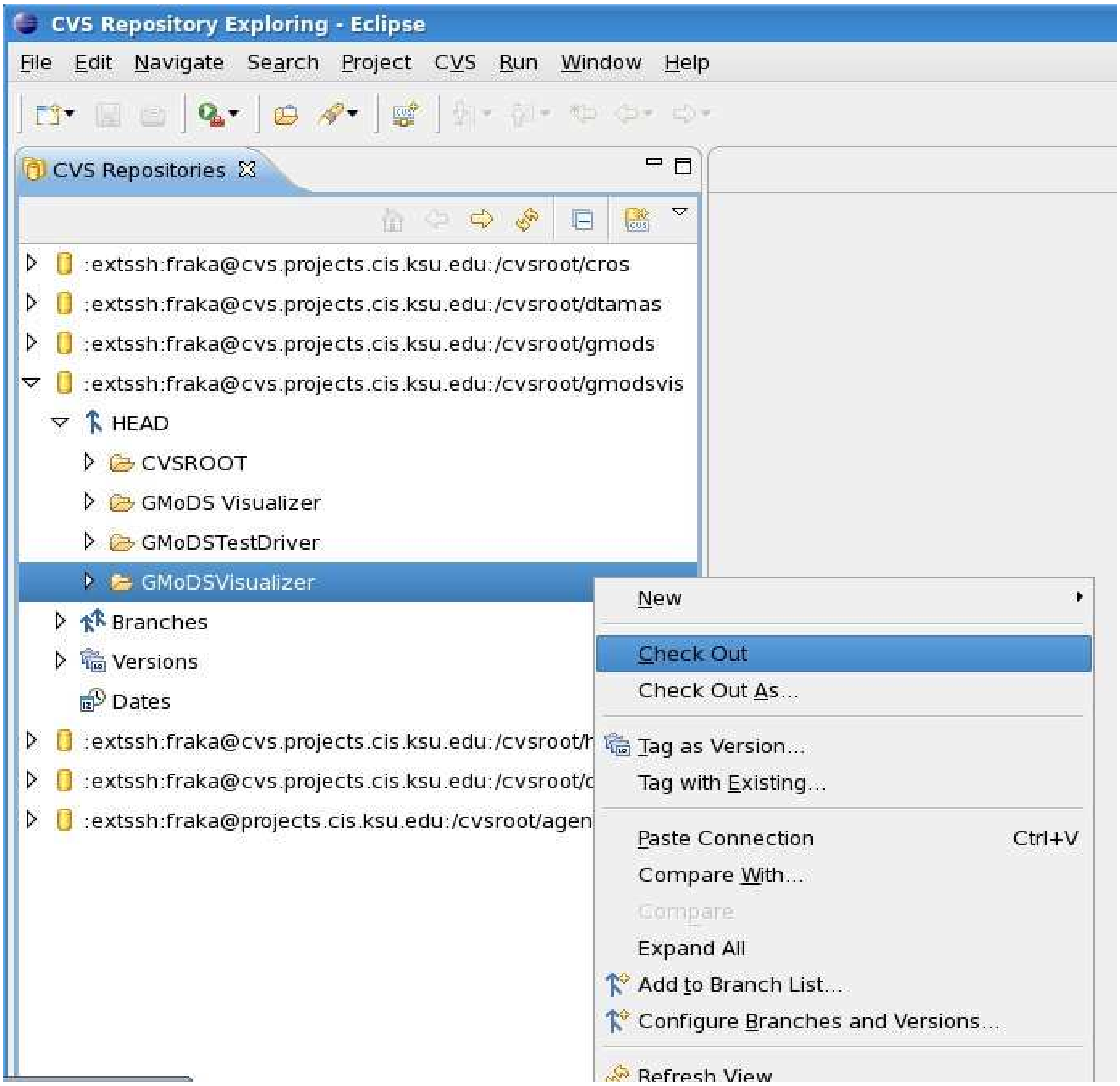
☑ Validate connection on finish

□ Save password (could trigger secure storage login)

To manage your password, please see 'Secure Storage'

Configure connection

Figure 92 Add a new CVS Repository



:extssh:fraka@cvs.projects.cis.ksu.edu:/cvsroot/cros
:extssh:fraka@cvs.projects.cis.ksu.edu:/cvsroot/dtamas
:extssh:fraka@cvs.projects.cis.ksu.edu:/cvsroot/gmods
:extssh:fraka@cvs.projects.cis.ksu.edu:/cvsroot/gmodsvis
HEAD
CVSROOT
GMoDS Visualizer
GMoDSTestDriver
GMoDSVisualizer
Branches
Versions
Dates
:extssh:fraka@cvs.projects.cis.ksu.edu:/cvsroot/h
:extssh:fraka@cvs.projects.cis.ksu.edu:/cvsroot/c
:extssh:fraka@projects.cis.ksu.edu:/cvsroot/agen

Figure 93 Check Out GMoDSVisualizer

Click the arrows to open “/cvsroot/gmodsvis” and “HEAD” then right click on “GMODSVisualizer” (not “GMODS Visualizer” an empty project) as shown in Figure 93 above. Choose “Check Out” or “Check Out As”.

10.2.1.2 Check out the projects the GMoDS Visualizer depends on

The GMoDS Visualizer depends on two other Eclipse projects: GMoDS and the Organization Model for Adaptive Complex Systems (OMACS). If you do not have these projects already checked out you must do so now.

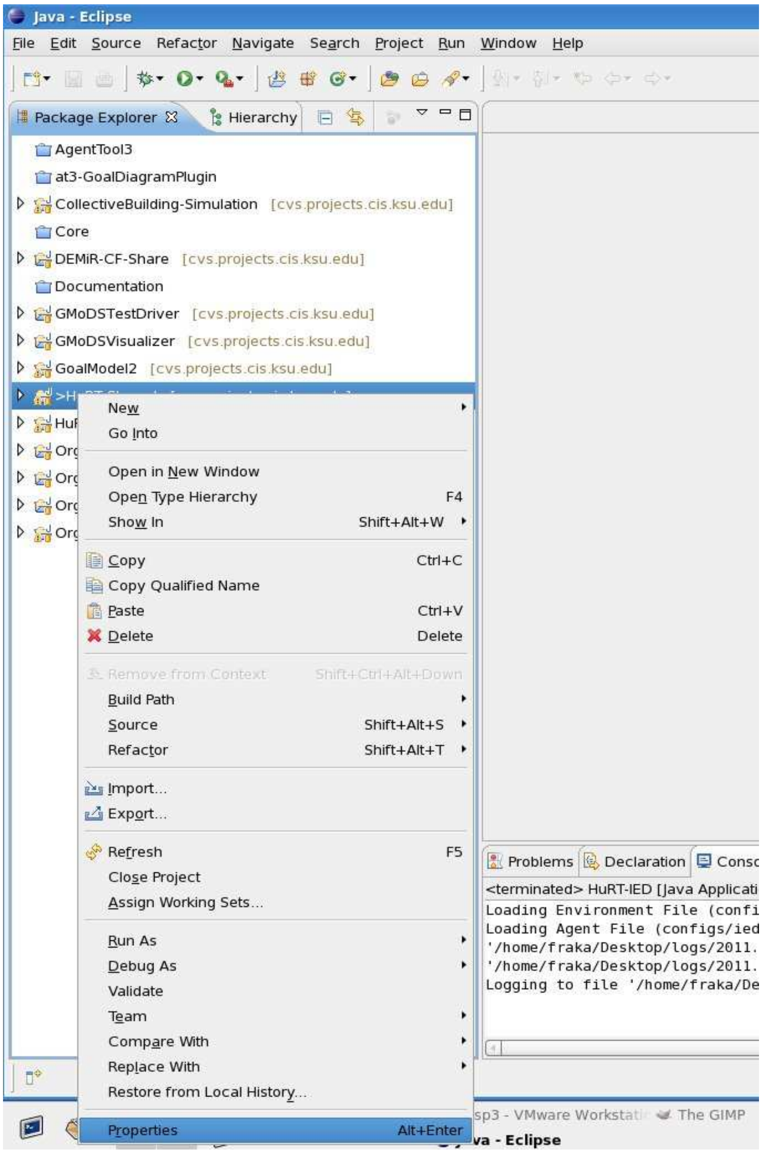
10.2.1.2.1 GMoDS

Follow the steps above to define the repository location for /cvsroot/gmods and then check out GoalModel2.

10.2.1.2.2 OMACS

Follow the steps above to define the repository location for /cvsroot/omacs and then check out OrganizationModel.

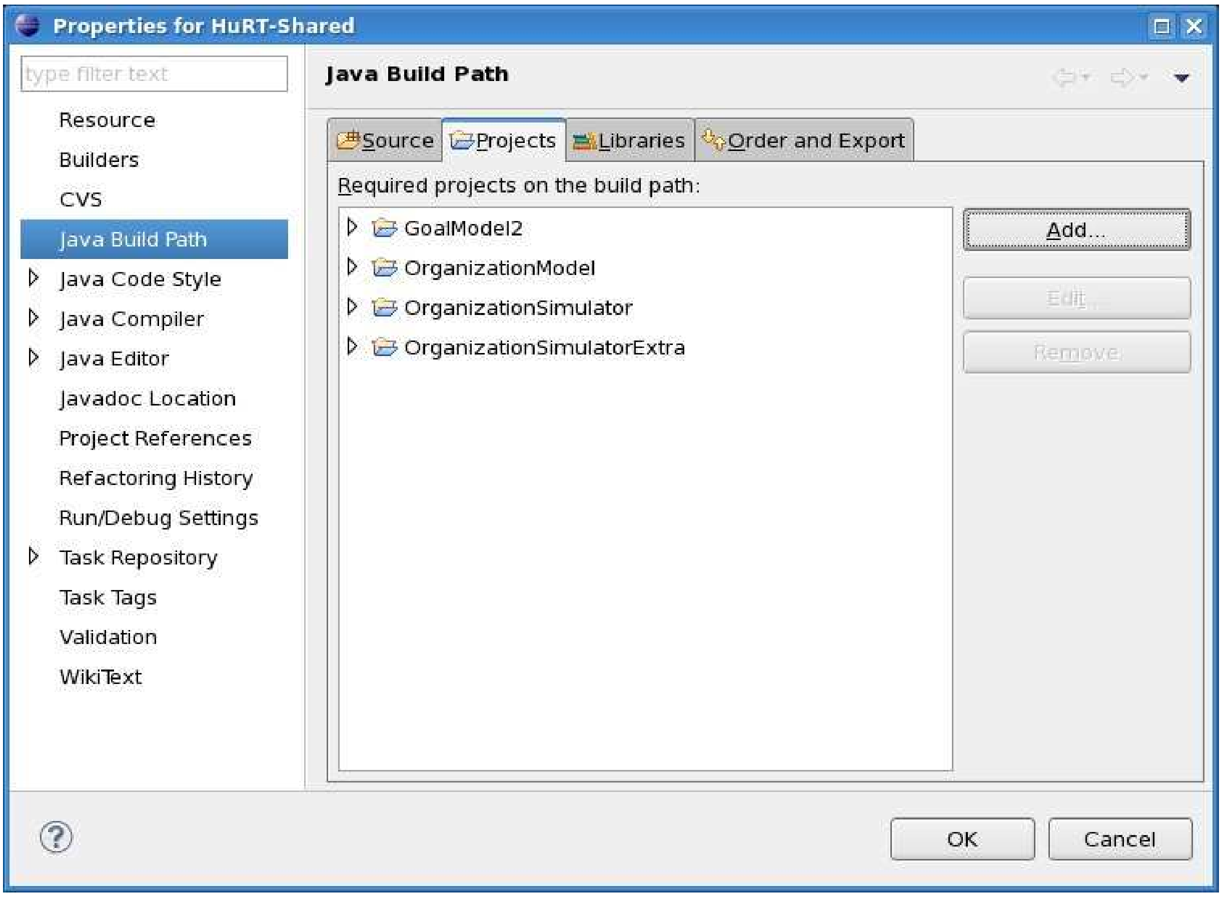
10.2.1.3 Make your Eclipse project depend on the GMoDS Visualizer



```
<terminated> HuRT-IED [Java Applicati
Loading Environment File (confi
Loading Agent File (configs/ied
'/home/fraka/Desktop/logs/2011.
'/home/fraka/Desktop/logs/2011.
Logging to file '/home/fraka/De
```

Figure 94 Project | Properties

In the Java perspective, right click the project that needs to use the GMoDS Visualizer and select "Properties" as shown above in Figure 94. In the dialog that pops up select "Java Build Path" as show in Figure 95 below. Click "Add" and select "GMoDSVisualizer" as shown in Figure 96 below.

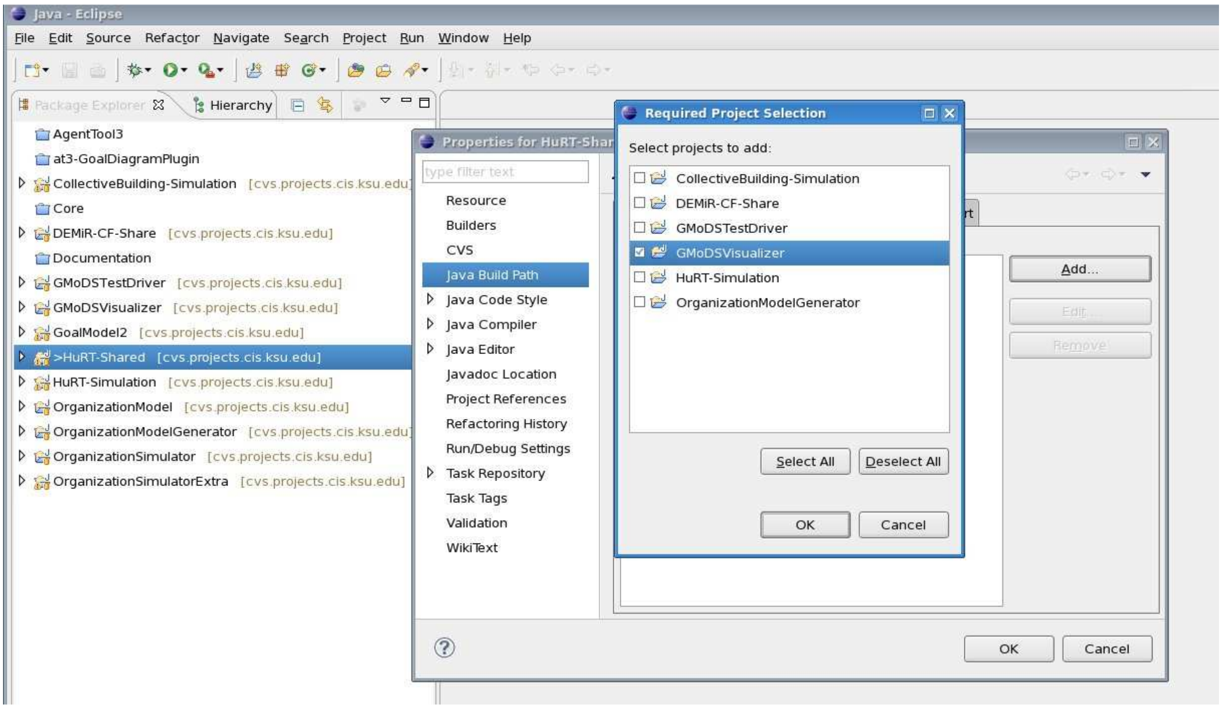


Java Build Path

Required projects on the build path:

- GoalModel2
- OrganizationModel
- OrganizationSimulator
- OrganizationSimulatorExtra

Figure 95 Java Build Path



- AgentTool3
- at3-GoalDiagramPlugin
- CollectiveBuilding-Simulation [cvs.projects.cis.ksu.edu]
- Core
- DEMiR-CF-Share [cvs.projects.cis.ksu.edu]
- Documentation
- GMoDSTestDriver [cvs.projects.cis.ksu.edu]
- GMoDSVisualizer [cvs.projects.cis.ksu.edu]
- GoalModel2 [cvs.projects.cis.ksu.edu]
- >HuRT-Shared [cvs.projects.cis.ksu.edu]
- HuRT-Simulation [cvs.projects.cis.ksu.edu]
- OrganizationModel [cvs.projects.cis.ksu.edu]
- OrganizationModelGenerator [cvs.projects.cis.ksu.edu]
- OrganizationSimulator [cvs.projects.cis.ksu.edu]
- OrganizationSimulatorExtra [cvs.projects.cis.ksu.edu]

Select projects to add:

☐ CollectiveBuilding-Simulation
☐ DEMiR-CF-Share
☐ GMoDSTestDriver
☑ GMoDSVisualizer
☐ HuRT-Simulation
☐ OrganizationModelGenerator

Figure 96 Required Project Selection

10.2.2 Usage

To use the GMoDS Visualizer in an application, one must construct GMoDSVisualizerImpl and then call its initialize() method. GMoDSVisualizerImpl takes 3 parameters:

1) SpecificationTree,
2) InstanceTree, and
3) Test Driver.

An application that uses GMoDS should have no trouble identifying objects that implement parameters 1 and 2 above. **The InstanceTree object must have its "initialize()" method called before being passed to the GMoDSVisualizerImpl constructor or an IllegalArgumentException will be thrown.** The application should send in "null" for the Test Driver.

To use the GMoDS Visualizer with the GMoDS Test Driver see 10.3 below.

10.2.3 Common Commands

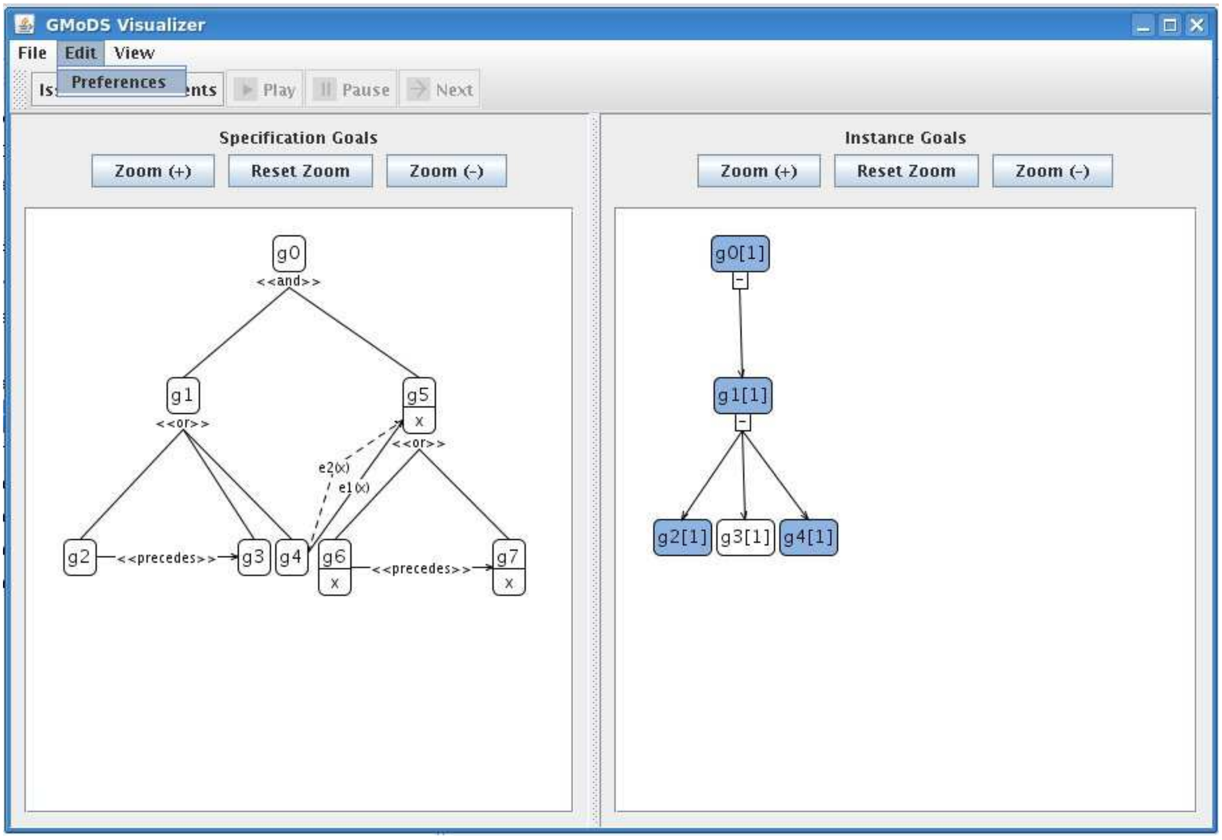
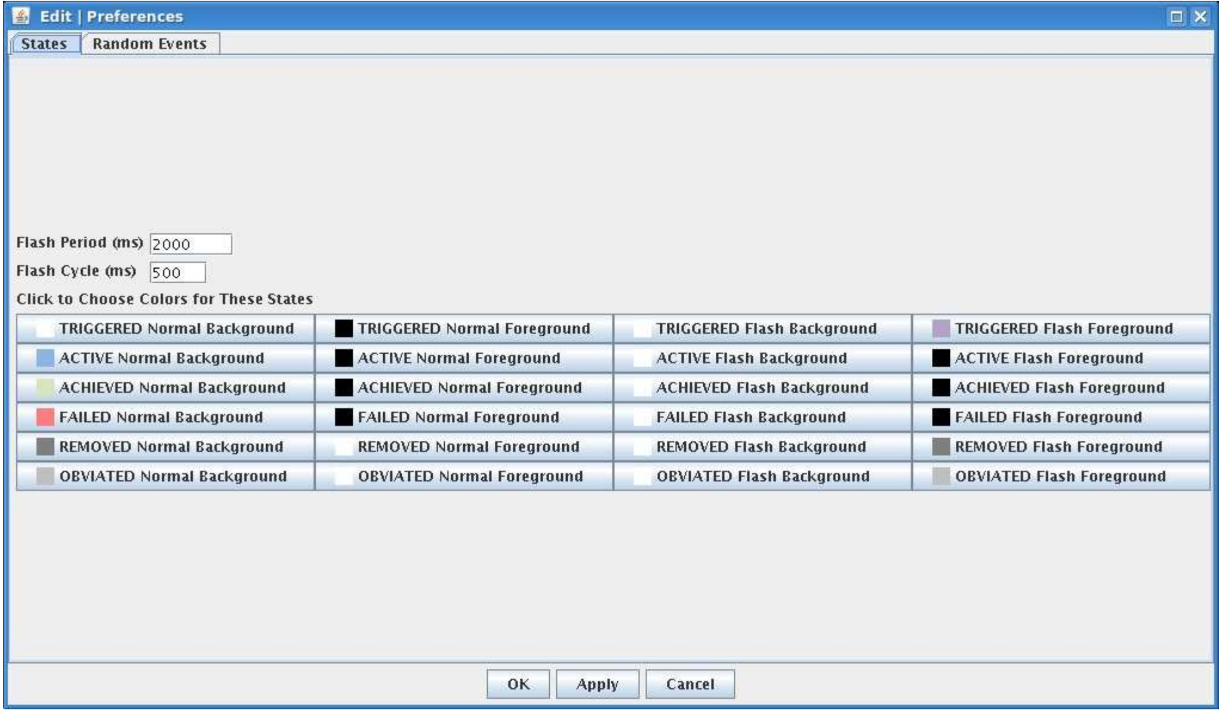


Figure 97 Edit | Preferences

Figure 97 above shows sample specification and instance trees for the goal diagram "VisionDocument2.goal". One can zoom the specification or instance tree using the applicable buttons. Figure 97 shows that one can "Edit | Preferences". Figure 98 below shows that one can “Edit | Preferences | States” for the GMoDS Visualizer. This allows one to pick the total time a changed goal will flash, the time for a single flash, and select colors for any goal state.



Flash Period (ms) 2000

Flash Cycle (ms) 500

Click to Choose Colors for These States

⬜ TRIGGERED Normal Background	⬛ TRIGGERED Normal Foreground	⬜ TRIGGERED Flash Background	🟪 TRIGGERED Flash Foreground
🟦 ACTIVE Normal Background	⬛ ACTIVE Normal Foreground	⬜ ACTIVE Flash Background	⬛ ACTIVE Flash Foreground
🟩 ACHIEVED Normal Background	⬛ ACHIEVED Normal Foreground	⬜ ACHIEVED Flash Background	⬛ ACHIEVED Flash Foreground
🟥 FAILED Normal Background	⬛ FAILED Normal Foreground	⬜ FAILED Flash Background	⬛ FAILED Flash Foreground
◼ REMOVED Normal Background	⬜ REMOVED Normal Foreground	⬜ REMOVED Flash Background	◼ REMOVED Flash Foreground
◻ OBVIATED Normal Background	⬜ OBVIATED Normal Foreground	⬜ OBVIATED Flash Background	◻ OBVIATED Flash Foreground

Figure 98 Edit | Preferences | States

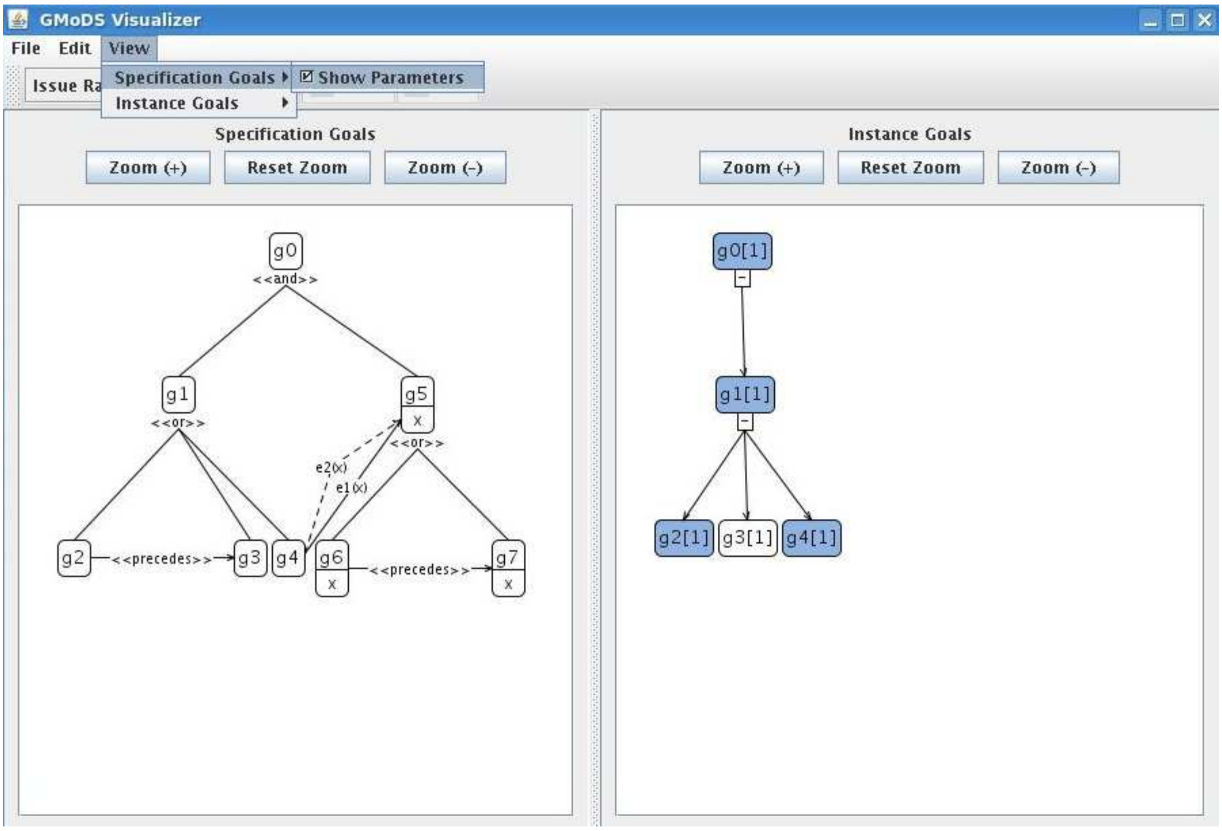


Figure 99 View | Specification Goals | Show Parameters

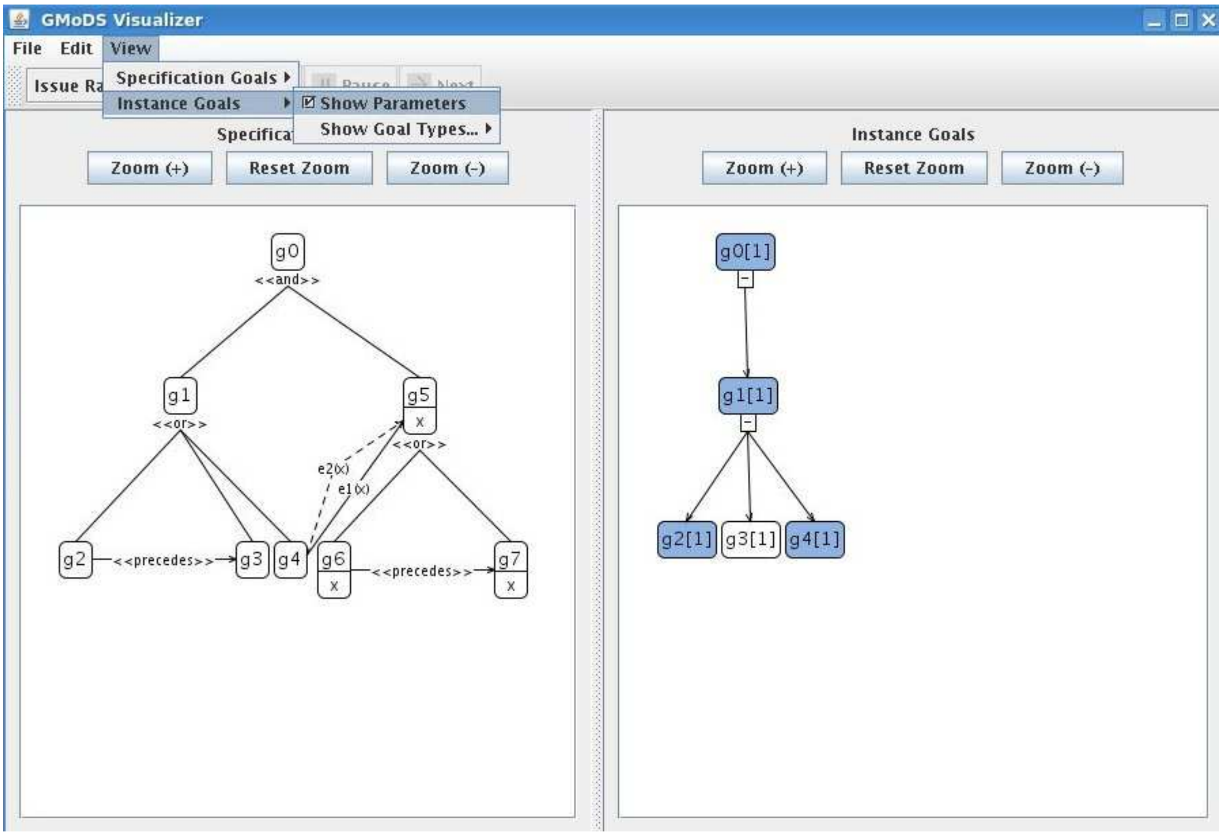


Figure 100 View | Instance Goals | Show Parameters

Figure 99 and Figure 100 above show one can view or not view the parameters throughout the specification or instance trees. Figure 101 below shows that one can view or not view all instance of any particular specification goal type. If a goal type is not viewed all descendants' instances are hidden.

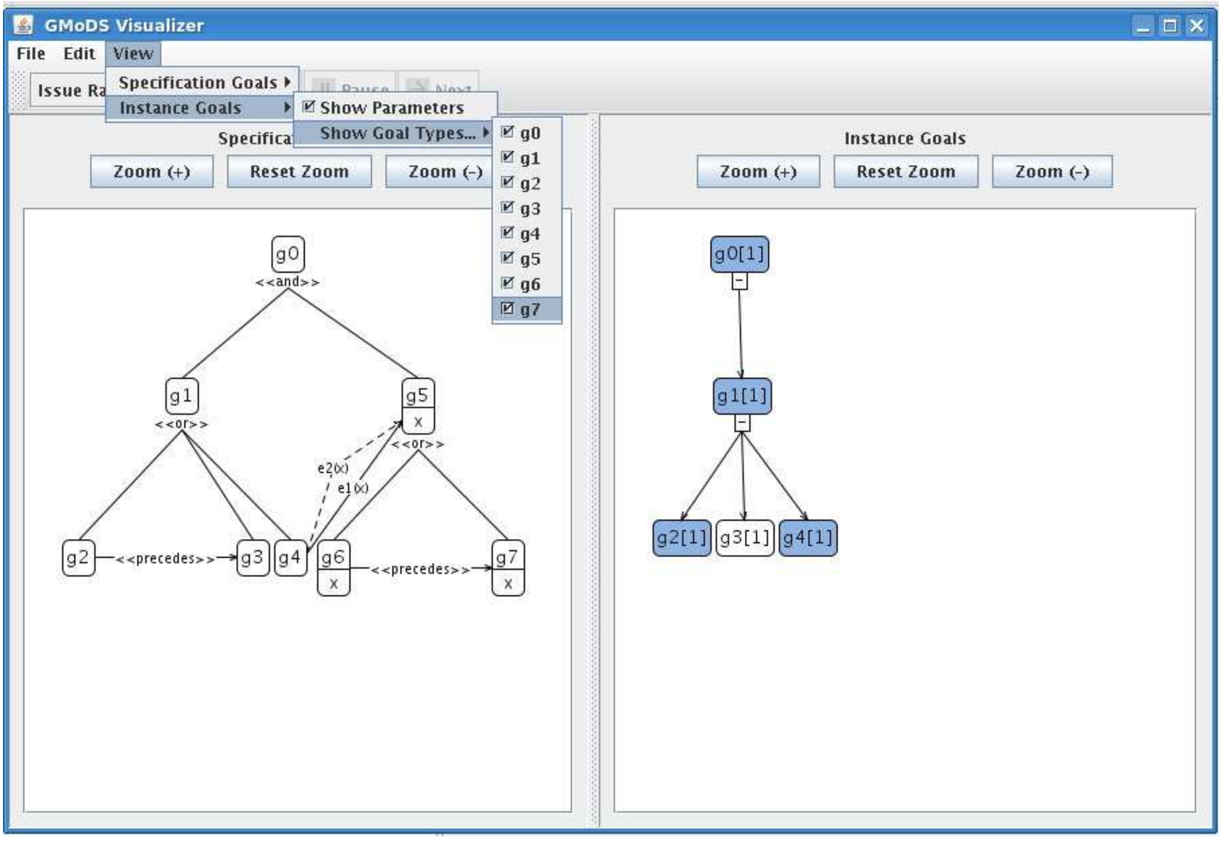


Figure 101 View | Instance Goals | Show Goal Types

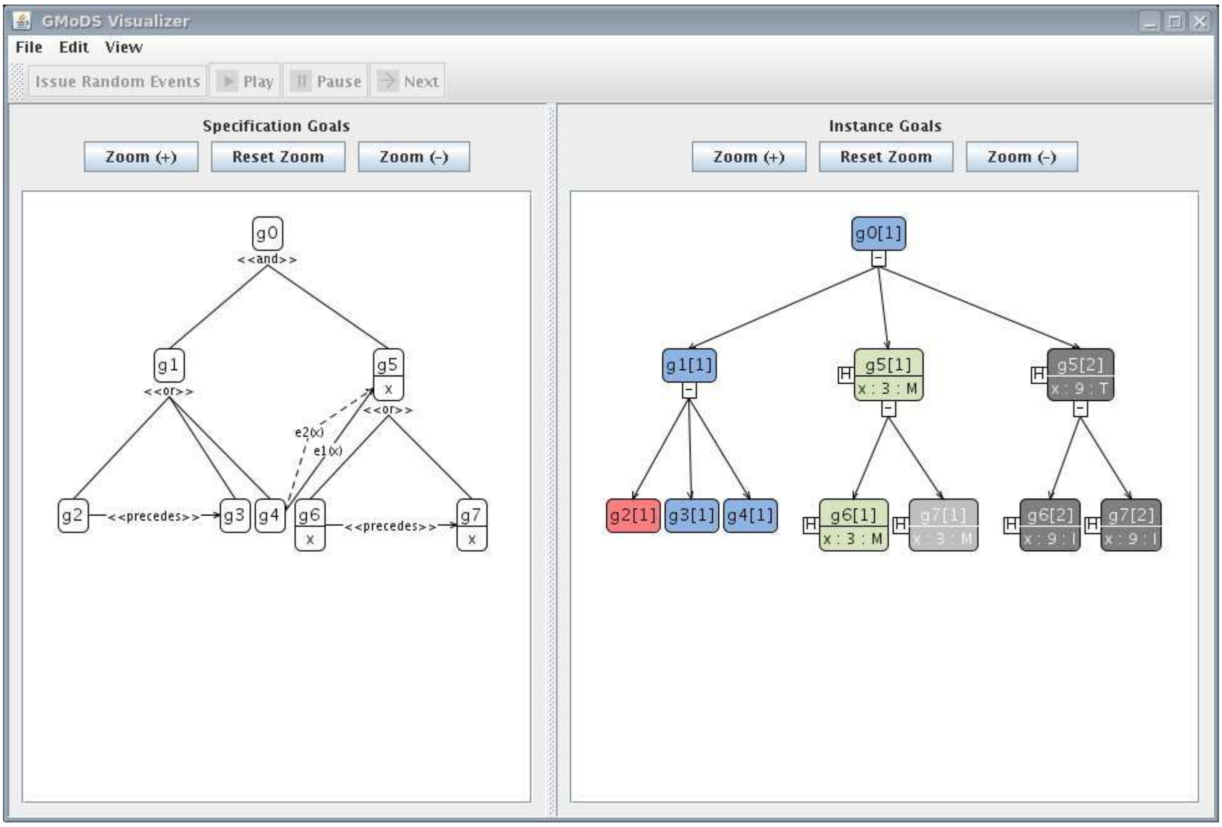


Figure 102 Valid events executed

Figure 102 above shows the same specification and instance trees after the script shown in Figure 112 below is executed. Compare Figure 103 and Figure 104 below to this figure. To collapse all child goals of a particular instance goal click the rectangle containing the “minus” sign below the instance goal. To expand the child goals, click the rectangle containing “plus” sign. To hide the parameters of a particular instance goal click the rectangle containing “H”. To show the parameters, click the rectangle containing “S”.

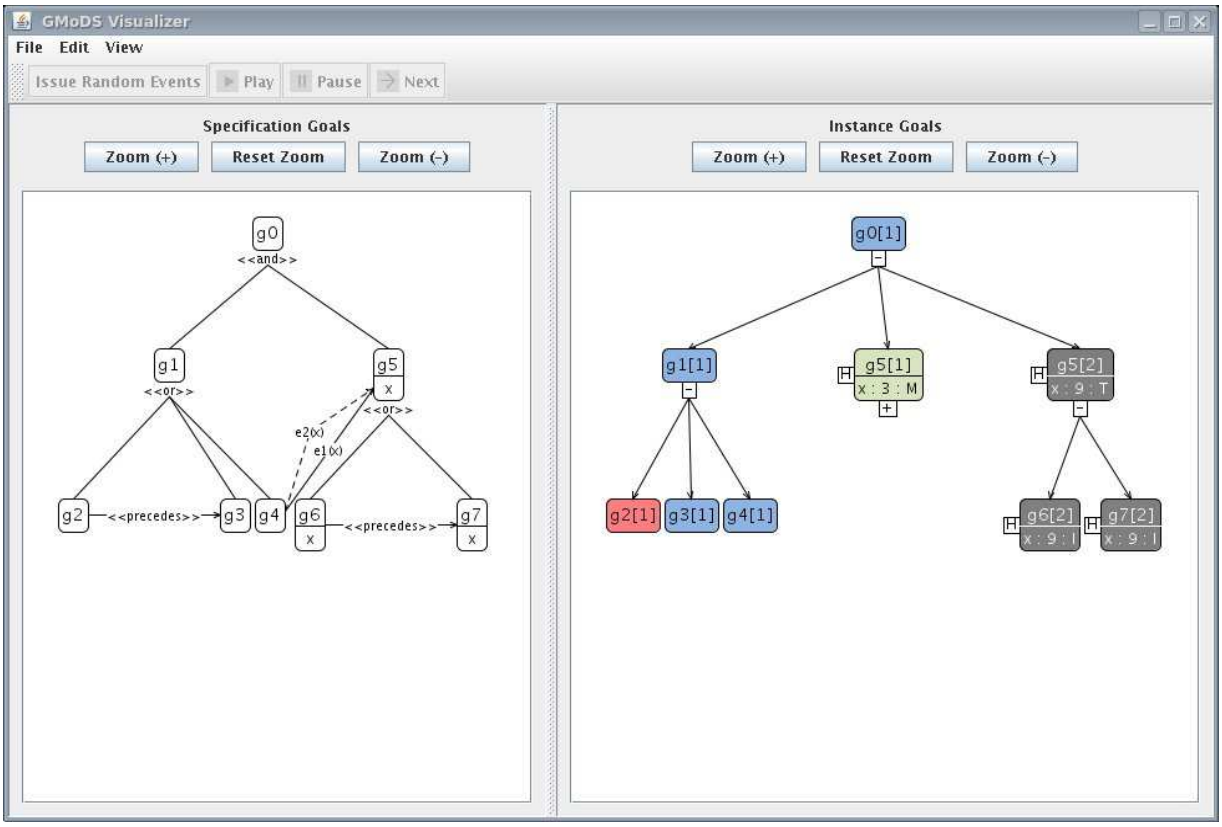


Figure 103 Collapse sub-goals

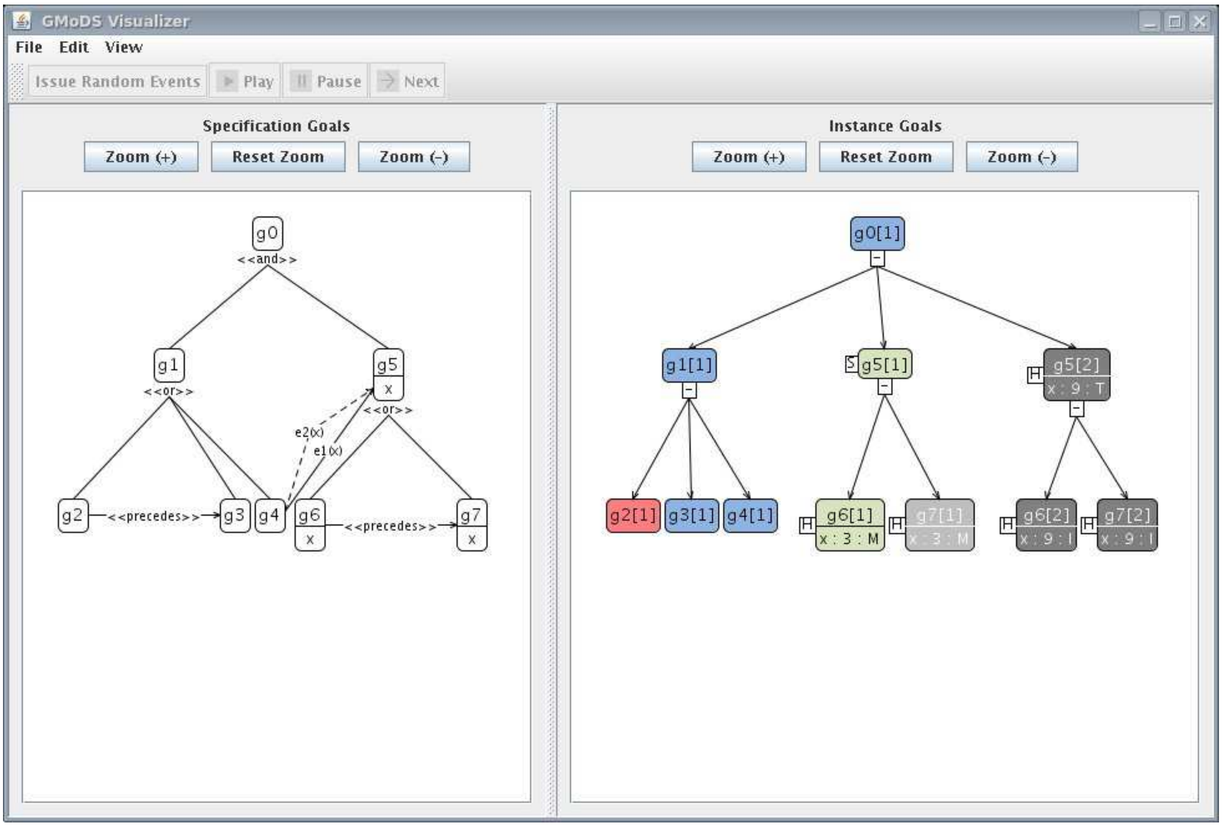


Figure 104 Hide parameters

10.3 GMoDS Test Driver

The GMoDS Test Driver can be used to test GMoDS or the GMoDS Visualizer using scripts or random events in manual or automatic mode.

10.3.1 Installation

10.3.1.1 Install the GMoDS Visualizer

Follow the steps in section 10.2.1 above, **skipping section 10.2.1.3.** Section 10.2.1.3 is skipped because the GMoDS Test Driver project already depends on the GMoDS Visualizer project.

10.3.1.2 Install the GMoDS Test Driver

Follow the steps in section 10.2.1 above except the CVS repository location /cvsroot/gmodsvis will already be defined and instead of "GMoDSVisualizer" check out "GMoDSTestDriver".

10.3.2 Usage

The project GMoDSTestDriver includes the folders "eventscripts" and "goalmodels" for sample event scripts and GMoDS goal models. The GMoDS Test Driver is launched using the class edu.ksu.cis.macr.goal.model.testdriver.launcher.Launcher. To run the GMoDS Test Driver, first define a run configuration as shown in Figure 105, Figure 106, and Figure 107 below. Then click the "Run" button.

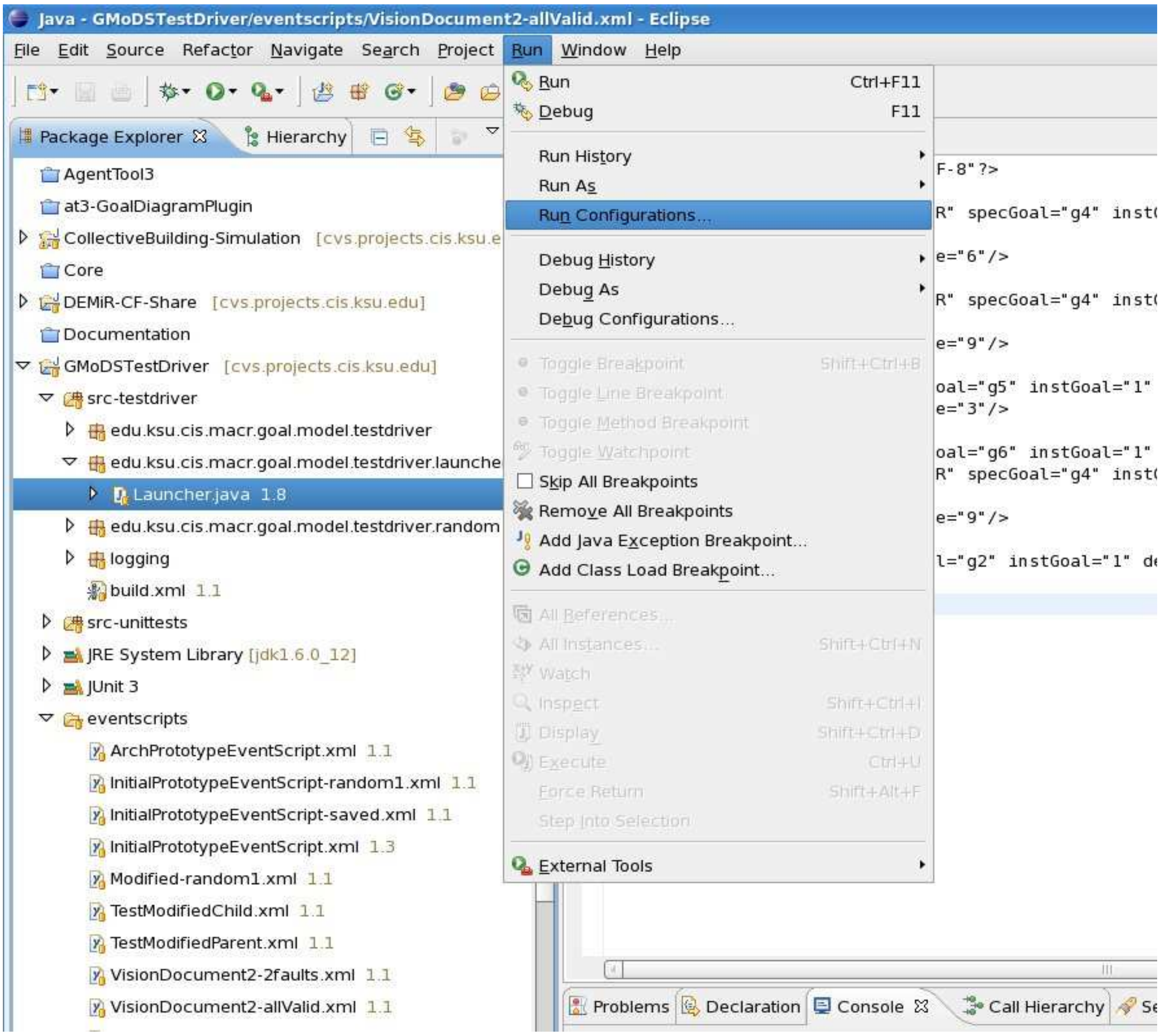
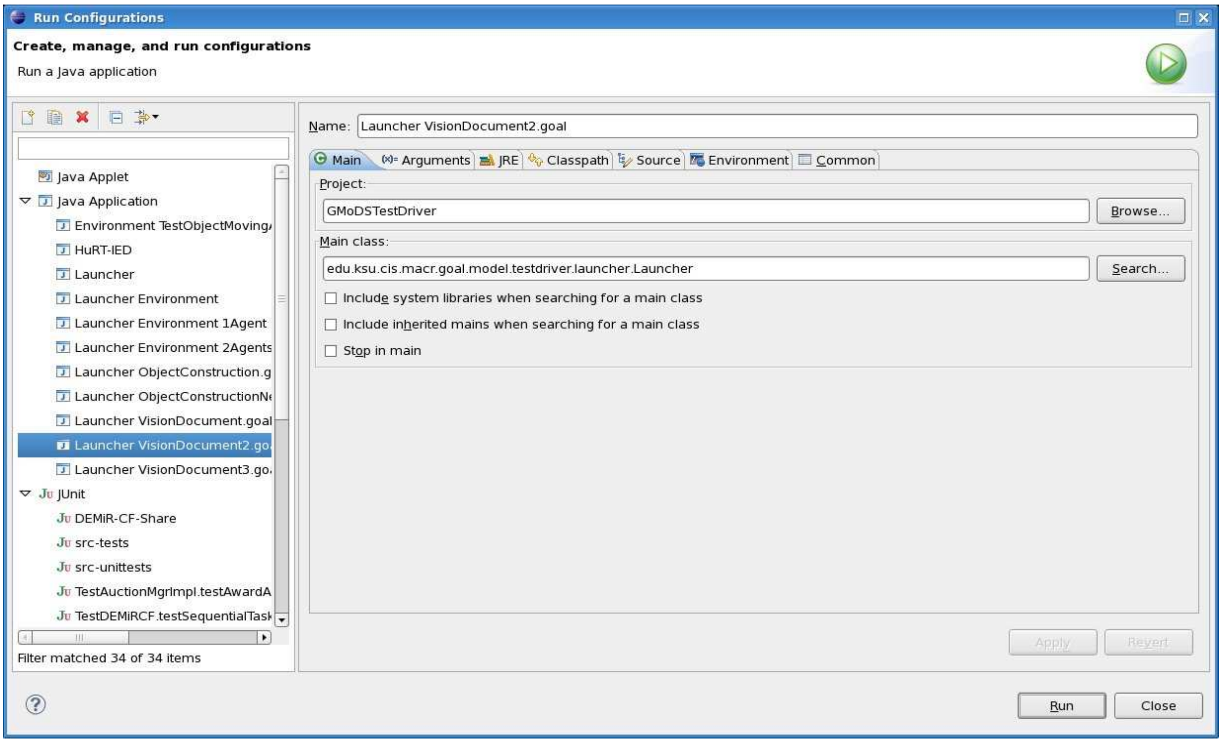

Java - GMoDSTestDriver/eventscripts/VisionDocument2-allValid.xml - Eclipse
File Edit Source Refactor Navigate Search Project Run Window Help
Package Explorer
Hierarchy
AgentTool3
at3-GoalDiagramPlugin
CollectiveBuilding-Simulation [cvs.projects.cis.ksu.e
Core
DEMiR-CF-Share [cvs.projects.cis.ksu.edu]
Documentation
GMoDSTestDriver [cvs.projects.cis.ksu.edu]
src-testdriver
edu.ksu.cis.macr.goal.model.testdriver
edu.ksu.cis.macr.goal.model.testdriver.launche
Launcher.java 1.8
edu.ksu.cis.macr.goal.model.testdriver.random
logging
build.xml 1.1
src-unittests
JRE System Library [jdk1.6.0_12]
JUnit 3
eventscripts
ArchPrototypeEventScript.xml 1.1
InitialPrototypeEventScript-random1.xml 1.1
InitialPrototypeEventScript-saved.xml 1.1
InitialPrototypeEventScript.xml 1.3
Modified-random1.xml 1.1
TestModifiedChild.xml 1.1
TestModifiedParent.xml 1.1
VisionDocument2-2faults.xml 1.1
VisionDocument2-allValid.xml 1.1
Run Ctrl+F11
Debug F11
Run History
Run As
Run Configurations...
Debug History
Debug As
Debug Configurations...
Toggle Breakpoint Shift+Ctrl+B
Toggle Line Breakpoint
Toggle Method Breakpoint
Toggle Watchpoint
□ Skip All Breakpoints
Remove All Breakpoints
Add Java Exception Breakpoint...
Add Class Load Breakpoint...
All References...
All Instances... Shift+Ctrl+N
Watch
Inspect Shift+Ctrl+I
Display Shift+Ctrl+D
Execute Ctrl+U
Force Return Shift+Alt+F
Step Into Selection
External Tools
F-8"?>
R" specGoal="g4" inst
e="6"/>
R" specGoal="g4" inst
e="9"/>
oal="g5" instGoal="1"
e="3"/>
oal="g6" instGoal="1"
R" specGoal="g4" inst
e="9"/>
l="g2" instGoal="1" de
Problems
Declaration
Console
Call Hierarchy
Se

Figure 105 Run Configurations



Run Configurations

Create, manage, and run configurations

Run a Java application

Name: Launcher VisionDocument2.goal

Project: GMoDSTestDriver

Main class: edu.ksu.cis.macr.goal.model.testdriver.launcher.Launcher

□ Include system libraries when searching for a main class

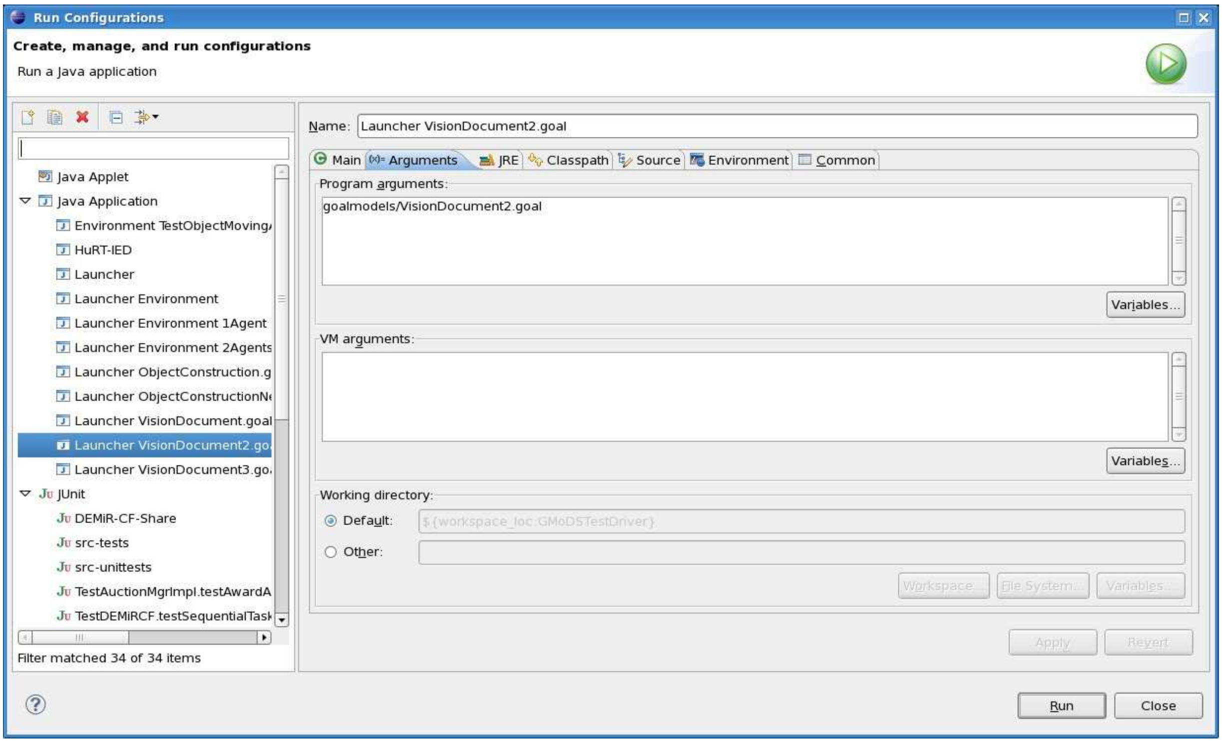
□ Include inherited mains when searching for a main class

□ Stop in main

Filter matched 34 of 34 items

Main
Arguments
JRE
Classpath
Source
Environment
Common
Browse...
Search...
Java Applet
Java Application
Environment TestObjectMoving
HuRT-IED
Launcher
Launcher Environment
Launcher Environment 1Agent
Launcher Environment 2Agents
Launcher ObjectConstruction.g
Launcher ObjectConstructionN
Launcher VisionDocument.goal
Launcher VisionDocument2.go
Launcher VisionDocument3.go
JUnit
DEMiR-CF-Share
src-tests
src-unittests
TestAuctionMgrImpl.testAwardA
TestDEMiRCF.testSequentialTask
Apply
Revert
Run
Close

Figure 106 GMoDS Test Driver Main



Run Configurations

Create, manage, and run configurations

Run a Java application

Name: Launcher VisionDocument2.goal

Program arguments:

goalmodels/VisionDocument2.goal

VM arguments:

Working directory:

● Default: ${workspace_loc:GMoDSTestDriver}

○ Other:

Filter matched 34 of 34 items

Main
Arguments
JRE
Classpath
Source
Environment
Common
Variables...
Variables...
Workspace...
File System...
Variables...
Java Applet
Java Application
Environment TestObjectMoving
HuRT-IED
Launcher
Launcher Environment
Launcher Environment 1Agent
Launcher Environment 2Agents
Launcher ObjectConstruction.g
Launcher ObjectConstructionN
Launcher VisionDocument.goal
Launcher VisionDocument2.go
Launcher VisionDocument3.go
JUnit
DEMiR-CF-Share
src-tests
src-unittests
TestAuctionMgrImpl.testAwardA
TestDEMiRCF.testSequentialTask
Apply
Revert
Run
Close

Figure 107 GMoDS Test Driver Arguments

10.3.3 Common Commands

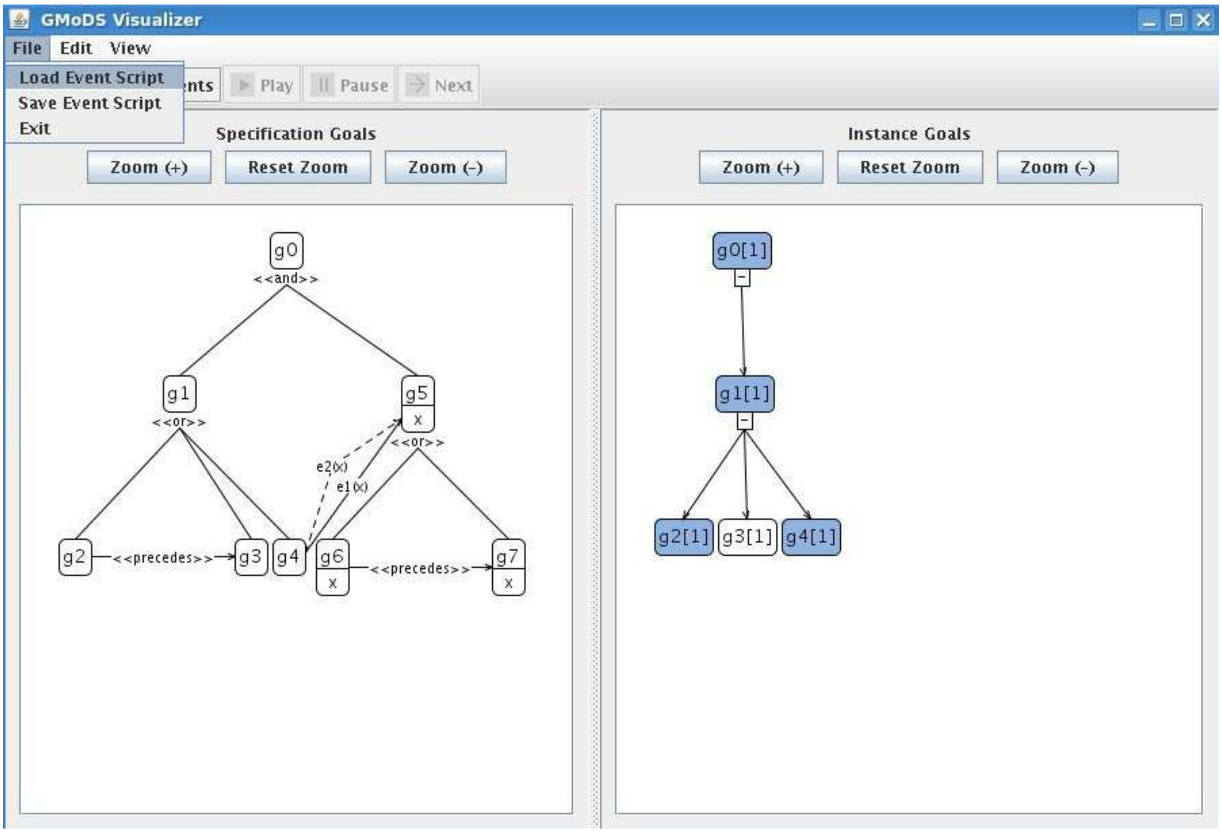


Figure 108 Load Event Script

Figure 108 above shows that the GMoDS Test Driver allows one to load or save an event script. Figure 109 below shows that one can issue random events (replacing any previously loaded event script), play an event script in automated mode, pause an event script and enter manual mode, or issue the next event manually. Figure 110 below shows that one can "Edit | Preferences | Random Events" to control the behavior of the GMoDS Test Driver when issuing random events.

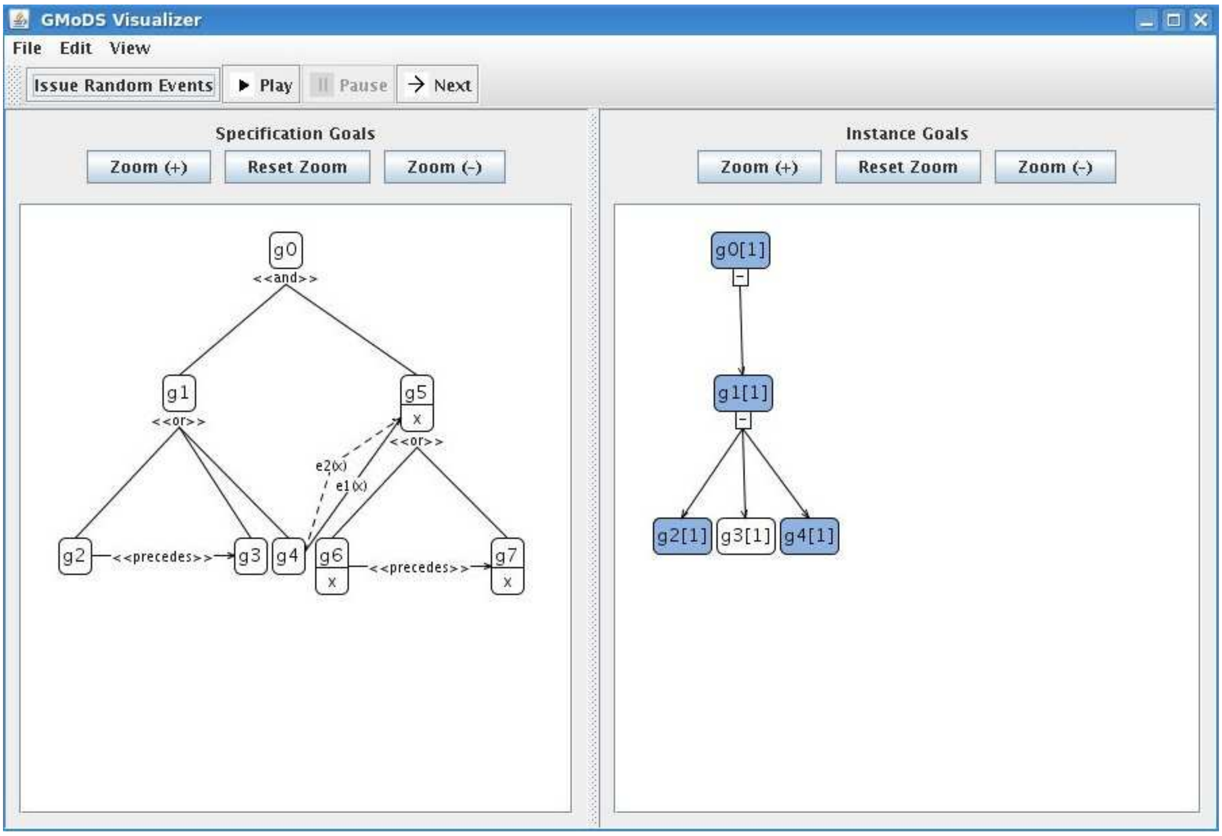
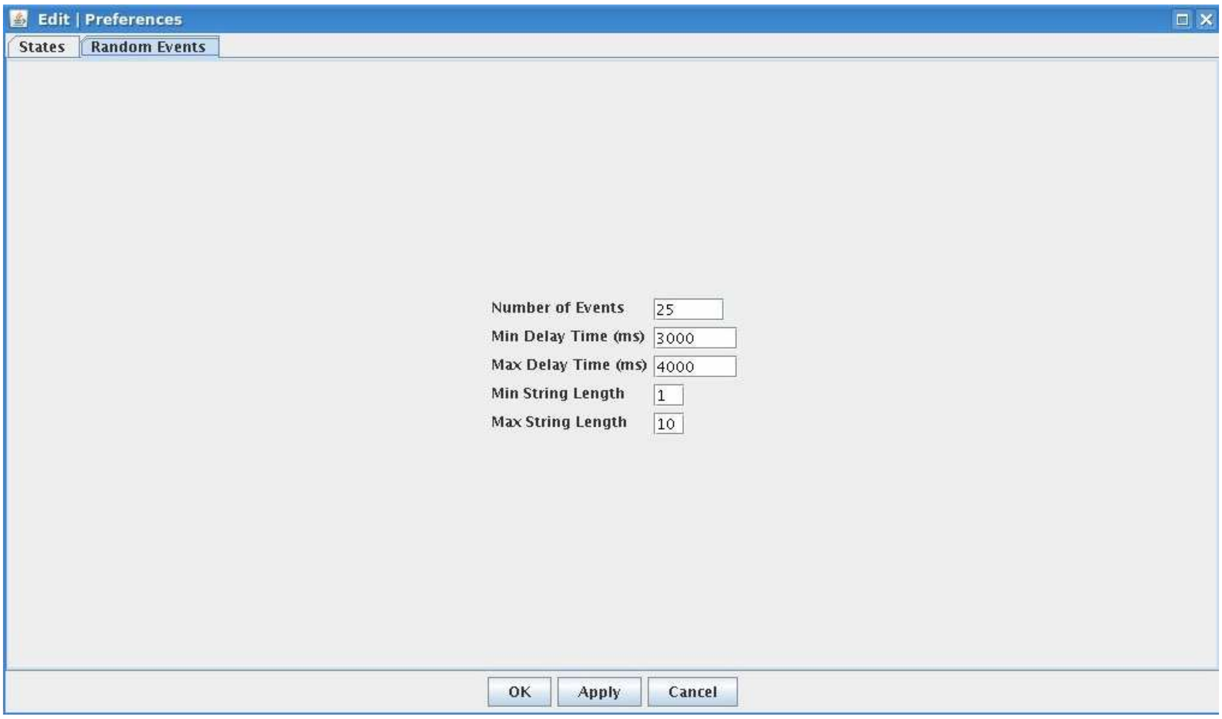


Figure 109 Test Driver controls



Number of Events	25
Min Delay Time (ms)	3000
Max Delay Time (ms)	4000
Min String Length	1
Max String Length	10

Figure 110 Edit | Preferences | Random Events

10.3.4 Event Script Format

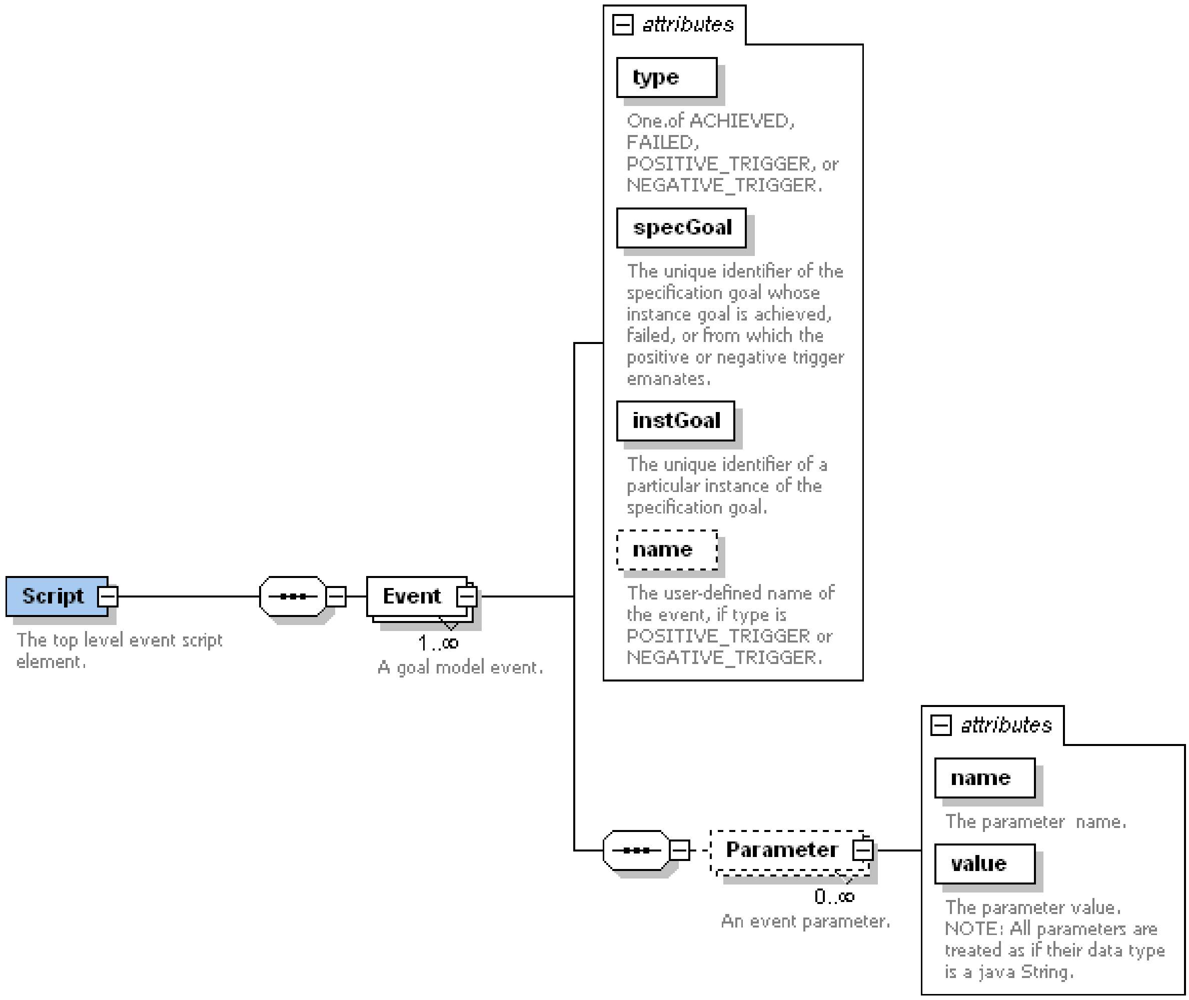
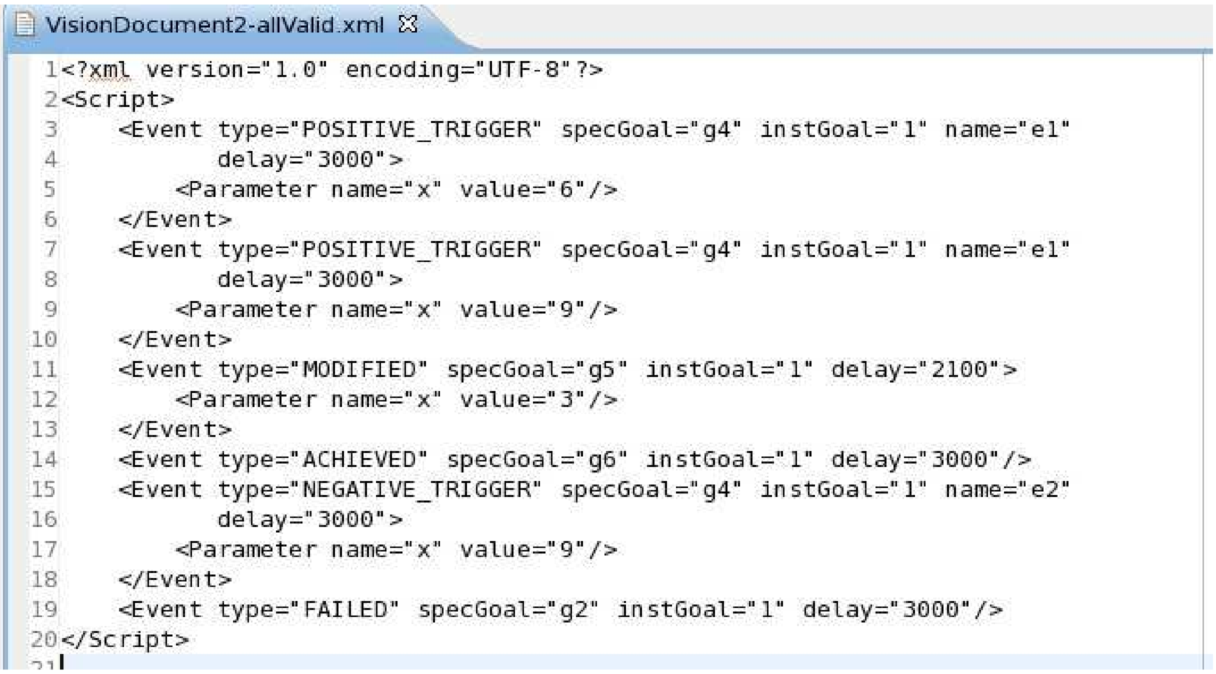

attributes
type
One of ACHIEVED, FAILED, POSITIVE_TRIGGER, or NEGATIVE_TRIGGER.
specGoal
The unique identifier of the specification goal whose instance goal is achieved, failed, or from which the positive or negative trigger emanates.
instGoal
The unique identifier of a particular instance of the specification goal.
name
The user-defined name of the event, if type is POSITIVE_TRIGGER or NEGATIVE_TRIGGER.
Script
The top level event script element.
Event
1..∞
A goal model event.
attributes
name
The parameter name.
value
The parameter value. NOTE: All parameters are treated as if their data type is a java String.
Parameter
0..∞
An event parameter.

Figure 111 GMoDS Test Driver Event Script XML Schema

Figure 111 above shows the XML Schema defining legal XML format for event script files. The GMoDS Test Driver does not validate event scripts using this schema so it is the user's responsibility to follow these formats. The XML parser will notify the user of badly formed XML by throwing an exception halting the load of the script (and requiring a restart of the GMoDS Test Driver).

Figure 112 below shows as a sample legal event script for the goal model "VisionDocument2.goal" using all event types.



```xml
<?xml version="1.0" encoding="UTF-8"?>
<Script>
    <Event type="POSITIVE_TRIGGER" specGoal="g4" instGoal="1" name="e1"
           delay="3000">
        <Parameter name="x" value="6"/>
    </Event>
    <Event type="POSITIVE_TRIGGER" specGoal="g4" instGoal="1" name="e1"
           delay="3000">
        <Parameter name="x" value="9"/>
    </Event>
    <Event type="MODIFIED" specGoal="g5" instGoal="1" delay="2100">
        <Parameter name="x" value="3"/>
    </Event>
    <Event type="ACHIEVED" specGoal="g6" instGoal="1" delay="3000"/>
    <Event type="NEGATIVE_TRIGGER" specGoal="g4" instGoal="1" name="e2"
           delay="3000">
        <Parameter name="x" value="9"/>
    </Event>
    <Event type="FAILED" specGoal="g2" instGoal="1" delay="3000"/>
</Script>
```

Figure 112 Sample Event Script

10.3.5 Log Messages

Table 66 Log Messages

Message	Meaning
addEvent,addEvent	A legal event was added to the current event script.
addEvent,Exception	An invalid event with respect to the SpecificationTree in GMoDS was not added to the current event script.
issueToGMoDS,event	A legal event was issued to GMoDS.
issueToGMoDS,modifyInstanceGoal	A legal MODIFIED event was issued to GMoDS.
next,Exception	The next command found an invalid event with respect to the current InstanceTree in GMoDS.

10.3.6 Error Messages

Table 67 Error Messages

Message	Meaning
"%s - improper specification event id %s"	The GMoDS Test Driver did not assign the correct internal specification event id to an ACHIEVED or FAILED event.
"%s - specification goal %s not defined"	The event’s “specGoal” attribute does not reference a legal specification goal.
"%s - specification goal %s is not a leaf goal"	The event’s “specGoal” attribute does not reference a leaf goal for an ACHIEVED or FAILED event type.

Message	**Meaning**
"%s - specification event %s not defined for specification goal %s"	The specification event referenced by the “name” attribute is not defined for the specification goal referenced by the “specGoal” attribute.
"%s - parameter names %s do not match those specified %s for specification goal %s"	The MODIFIED goal events’ Parameter “name” attribute does not match any specified for the specification goal referenced by “specGoal”.
"%s - parameter names %s do not match those specified %s for specification event %s for specification goal %s"	A POSITIVE_TRIGGER or NEGATIVE_TRIGGER goal events’ Parameter “name” attribute does not match any specified for that trigger in the specification tree for “specGoal”.
"%s - specification event %s not a negative trigger defined for specification goal %s"	A NEGATIVE_TRIGGER goal event’s “name” attribute does not refer to a negative trigger in the specification tree for “specGoal”.
"%s - specification event %s not a positive trigger defined for specification goal %s"	A POSITIVE_TRIGGER goal event’s “name” attribute does not refer to a positive trigger in the specification tree for “specGoal”.
"%s - instance goal %s not defined"	The instance goal referenced by “specGoal” and “instGoal” does not exist in the instance tree (yet).
"%s - instance goal %s not active"	The instance goal referenced by “specGoal” and “instGoal” is not an active goal for an event “type” other than MODIFIED.
"%s - instance goal %s's negative trigger parameter values %s do not match any instance goal."	No instance goal exists in the instance tree that is negatively triggered by the negative trigger referenced by “name” on “specGoal” with instance parameter names that match the Parameter “name” attributes in the goal event.
"%s - unspecified triggering instance goal: %s"	The instance goal referenced by the goal event was not found during issueToGMoDS.

11 Chapter 11 Project Evaluation

11.1 Introduction

This document is the evaluation of the GMoDS Test Driver and Visualizer project and product.

11.2 Process

11.2.1 Problems Encountered

This section lists problems encountered on the project.

11.2.1.1 Drawing with Java 2D

I had little experience drawing with Java 2D prior to the project. It so happened that in parallel with this project I was assigned a project at work that also required I use this capability. The two efforts were mutually beneficial.

11.2.1.2 Scrolling a Zoomed Drawing

I had no appreciation for the requirements of placing a customized Component that changes size in a JScrollPane and no experience with zoom on an image.

11.2.1.3 Designing an Indirect Routing Algorithm for Relations

The projects' top technical challenge was the algorithm for routing indirect relations avoiding intersections with goals and minimizing crossing of relations.

11.2.1.4 Supporting the Modification Parameter Origin Value

GMoDS does not directly support the "Modification" parameter origin value. My simple solution was to revise a copy of InstanceParameters (called ModifiableInstanceParameters) to persistently track the value of each parameter. Any time a parameter value changes the "Modification" parameter value origin could be attributed to it.

GMoDS has an unresolved issue regarding the behavior of the InstanceTree method modifyInstanceGoal with respect to generating a proper parameter origin value for child goals when their parent is directly modified. In my opinion, the parameter origin value displayed for these child goals parameters that match the modified parameter in the parent should be "Inherited" (I). However, GMoDS sends the value of the "inherited" property for these parameters as false when it calls the ChangeManager method notifyInstanceGoalModified for the child goals. If GMoDS sent the value of "inherited" as true, the GMoDS Visualizer would display a parameter value origin of "I" instead of "M" (modified).

11.2.2 Estimates

This section compares cost estimates for source lines of code and project duration estimated in phases 1 and 2 to the final totals.

11.2.2.1 Source Lines of Code

Table 68 Estimates of SLOC by phase

Phase	SLOC Estimate
Phase 1	4K
Phase 2	7K
Phase 3	8.3K (Actual)

Table 68 above shows the estimated number of source lines of code by phase of this project. This table shows that the estimate improved with feedback through the process and came within 1300 lines of the actual value.

11.2.2.2 Project Duration

Table 69 Comparing estimated and actual durations

Phase	Estimated End Date	Actual End Date
Phase 1	11/10/2010	11/22/2010
Phase 2	2/14/2011	1/13/2011
Phase 3	4/14/2011	3/16/2011

Table 69 above shows that I underestimated the time required for phase 1 but overestimated the time for the final 2 phases. Figure 114 below shows the percentage of time spent in each phase. Phase 1 took the most time as understanding of the project and Java 2D was a time intensive process. Phases 1 and 2 were less demanding.

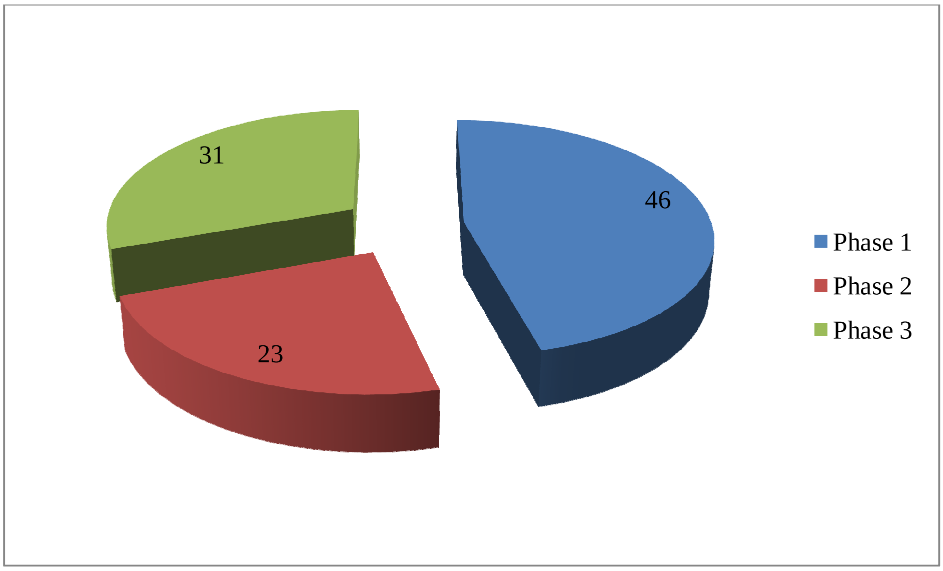


Figure 113 Percent of time spent in each phase

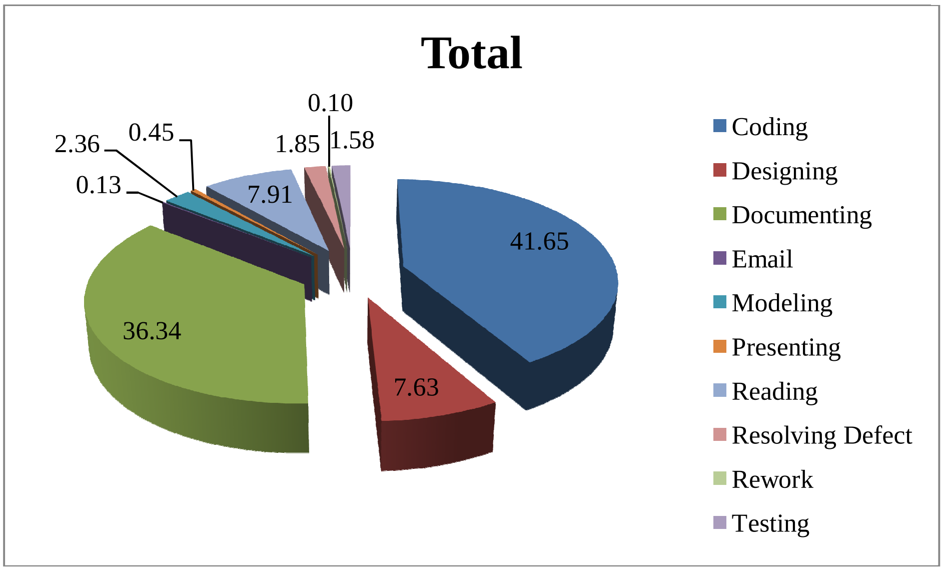


Figure 114 Percent of time for each task for the project

Figure 114 above shows the percent of time spent on each type of task for the entire project. Figure 115 below shows the same information for just phase 1.

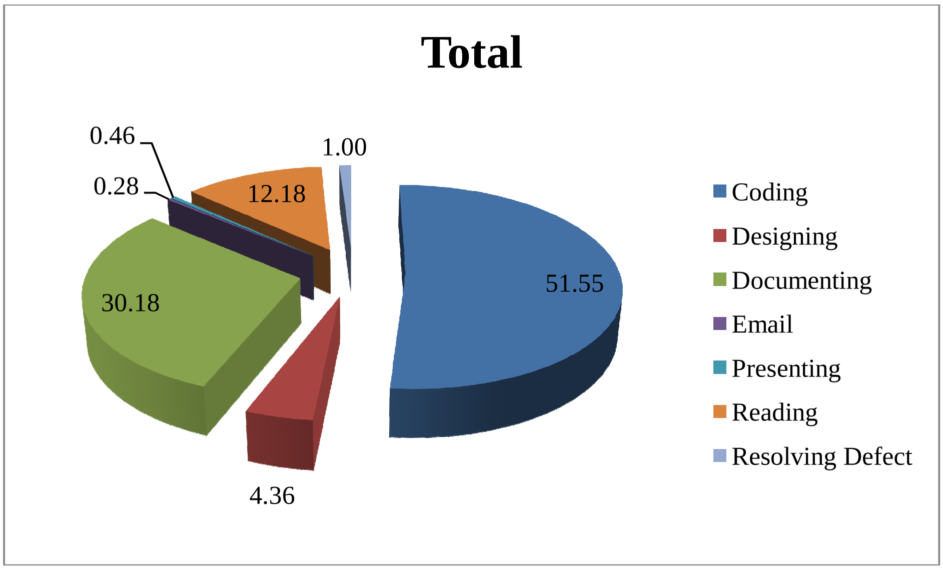


Figure 115 Percent of time for each task in phase 1

Figure 116 and Figure 117 below show the same break down for phases 2 and 3, respectively.

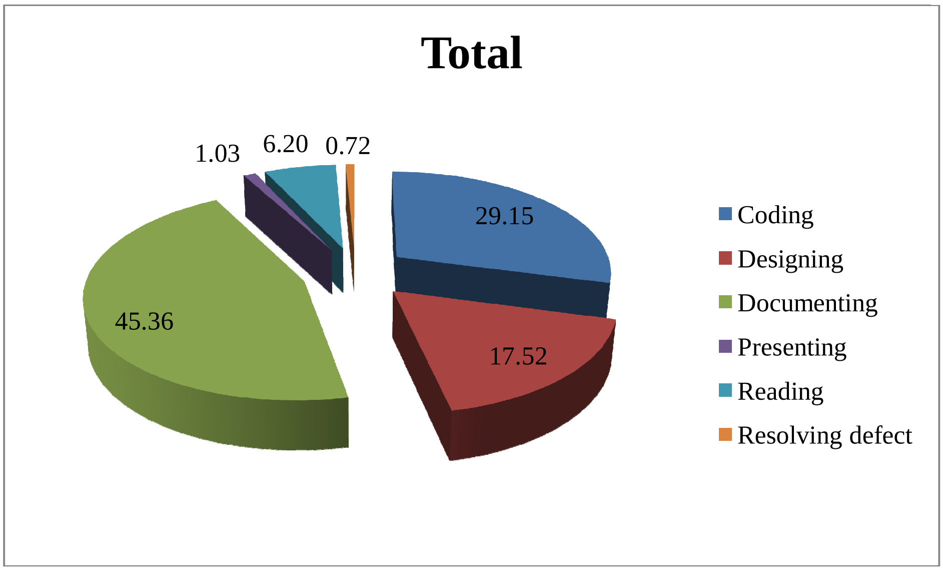


Figure 116 Percent of time for each task in phase 2

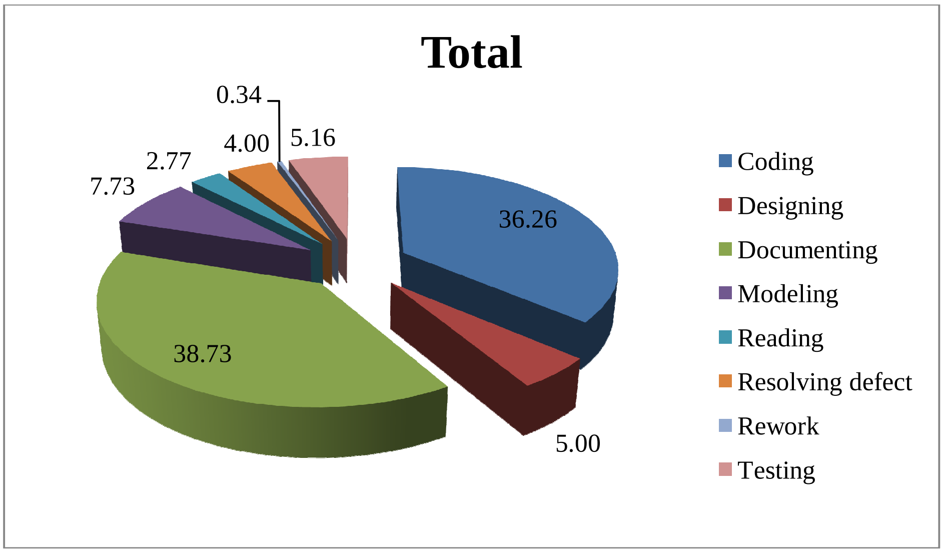


Figure 117 Percent of time for each task in phase 3

Table 70 below shows the actual time in hours spent in each task by phase. Phase 1 was most intensive for coding and reading due to the time needed to understand the project requirements and the Java 2D technology. Testing occurred in phase 3, as planned, leading to most of the rework occurring then.

Table 70 Time (in hours) for each task by phase

	Coding	**Designing**	**Documenting**	**Modeling**	**Reading**	**Rework**	**Testing**	**Other**	**Grand Total**
Phase 1	65.58	5.55	38.40	0.00	15.50	1.27	0.00	0.83	127.23
Phase 2	18.80	11.30	29.25	0.00	4.00	0.47	0.00	0.67	64.48
Phase 3	30.55	4.22	32.63	6.52	2.33	3.65	4.35	0.00	84.25
Grand Total	114.93	21.07	100.28	6.52	21.83	6.39	4.35	1.50	275.97

11.2.3 Lessons Learned

11.2.3.1 Writing a Valid Scrolling Client

The Java Swing JScrollPane requires that any client update its preferred size and call revalidate() prior to calling repaint(). This change fixed a bug with scrolling a zoomed image.

11.2.3.2 The Rational Unified Process Works

I learned that executing the Rational Unified Process indeed increases the confidence one should place in plans as the project unfolds. The highly uncertain first phase gave way to confident execution of phases two and three.

11.3 Products

This section reviews the products of the project for quality and for possible improvements in the future.

11.3.1 Quality

11.3.1.1 Rework Ratio

The rework ratio defined is as:

$$RW = \frac{E_{Defects}}{E_{Development}}$$

where $E_{Defeects}$ is the effort spent fixing defects and $E_{Development}$ is the effort spent developing code. Figure 118 below shows the plot of Rework Ratio over time throughout this project. As expected, since the majority of testing occurred at the end of the project the ratio increases as the majority of defects are found. I believe that continued use of the GMoDS Test Driver and Visualizer would lead to a Rework Ratio that declines to near zero over time.

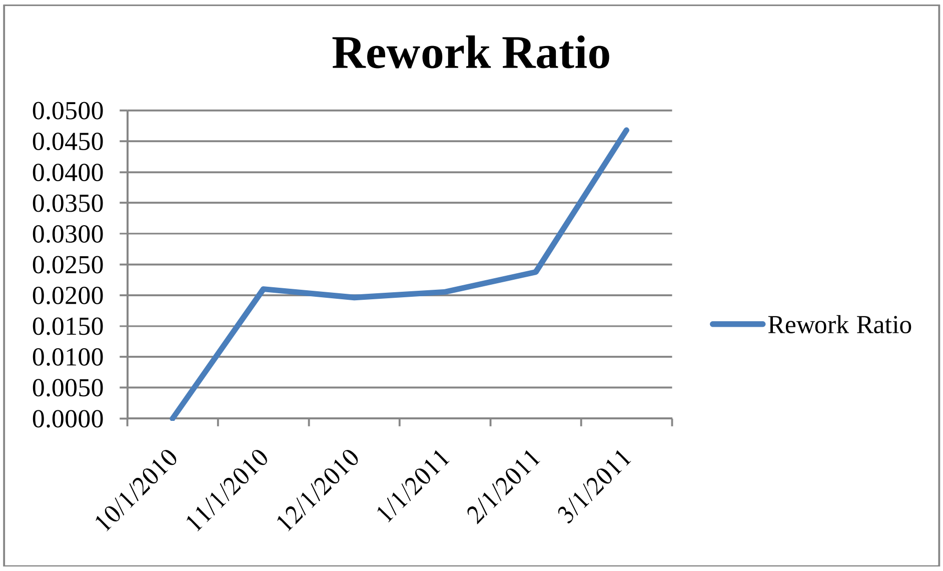


Figure 118 Rework Ratio

11.3.1.2 Mean Time between Failures

[8] defines Mean Time between Failures (MTBF) as the average usage time between software faults and states that "In rough terms, MTBF is computed by dividing the test hours by the numbers of type 0 and type 1 SCOs". In my case, I used the cumulative number of test hours divided by the cumulative number of faults.

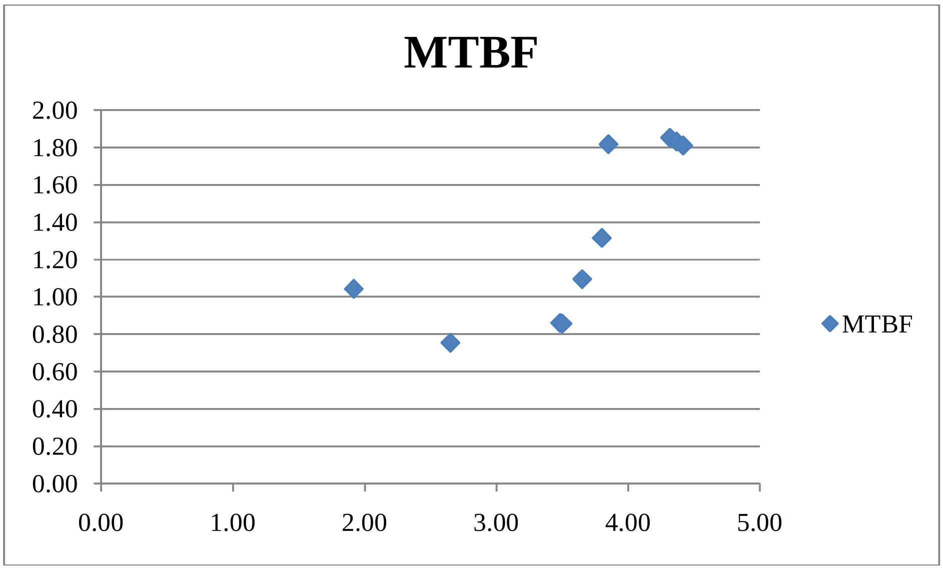


Figure 119 Mean Time between Failures

Figure 119 above shows a rising MTBF as testing begins and a bit of leveling off at the end as no more defects are found. I believe that MTBF will increase as the GMoDS Test Driver and Visualizer are put into production use.

11.3.2 Future Work

This section lists some future work that could improve the GMoDS Visualizer and Test Driver.

11.3.2.1 Dynamic Specification Tree Display

The GMoDS ChangeManager interface can notify the GMoDS Visualizer of changes to the specification tree similar to changes to the instance tree. It would not be difficult to change the Visualizer to respond to these changes by redrawing the specification tree.

11.3.2.2 Display Events Executed in the GMoDS Test Driver

The GMoDS Visualizer UI could be enhanced to display the list of events as they issued by the GMoDS Test Driver to GMoDS. This could improve the feedback and learning about GMoDS a user of the Test Driver experiences.

12 References

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10. “USEOCLmodeling.zip” available at http://people.cis.ksu.edu/~mfraka/FrakaMSE.html. This file contains the USE model and command scripts used to model the pre and post conditions of the method EventScriptImpl::addEvent.